

Reproduced by

**Armed Services Technical Information Agency**  
**DOCUMENT SERVICE CENTER**

**KNOTT BUILDING, DAYTON, 2, OHIO**

**AD -**

**10917**

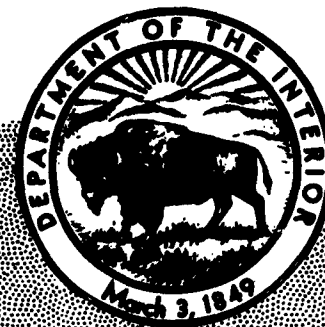
---

**UNCLASSIFIED**

**Best  
Available  
Copy**

CIRC. 210

GEOLOGICAL SURVEY CIRCULAR 210



**STRATIGRAPHIC SECTIONS OF THE  
PHOSPHORIA FORMATION IN  
WYOMING, 1947-48**

**By V. E. McKelvey, L. E. Smith, R. A. Hoppin, and F. C. Armstrong**

DWG. 10 917  
ASTIA FILE COPY

UNITED STATES DEPARTMENT OF THE INTERIOR  
Douglas McKay, Secretary

GEOLOGICAL SURVEY  
W. E. Wrather, Director

---

GEOLOGICAL SURVEY CIRCULAR 210

---

STRATIGRAPHIC SECTIONS OF THE PHOSPHORIA FORMATION  
IN WYOMING, 1947-48

By V. E. McKelvey, L. E. Smith, R. A. Hoppin, and F. C. Armstrong

This report concerns work done partly on behalf of the  
U. S. Atomic Energy Commission  
and is published with the permission of the Commission

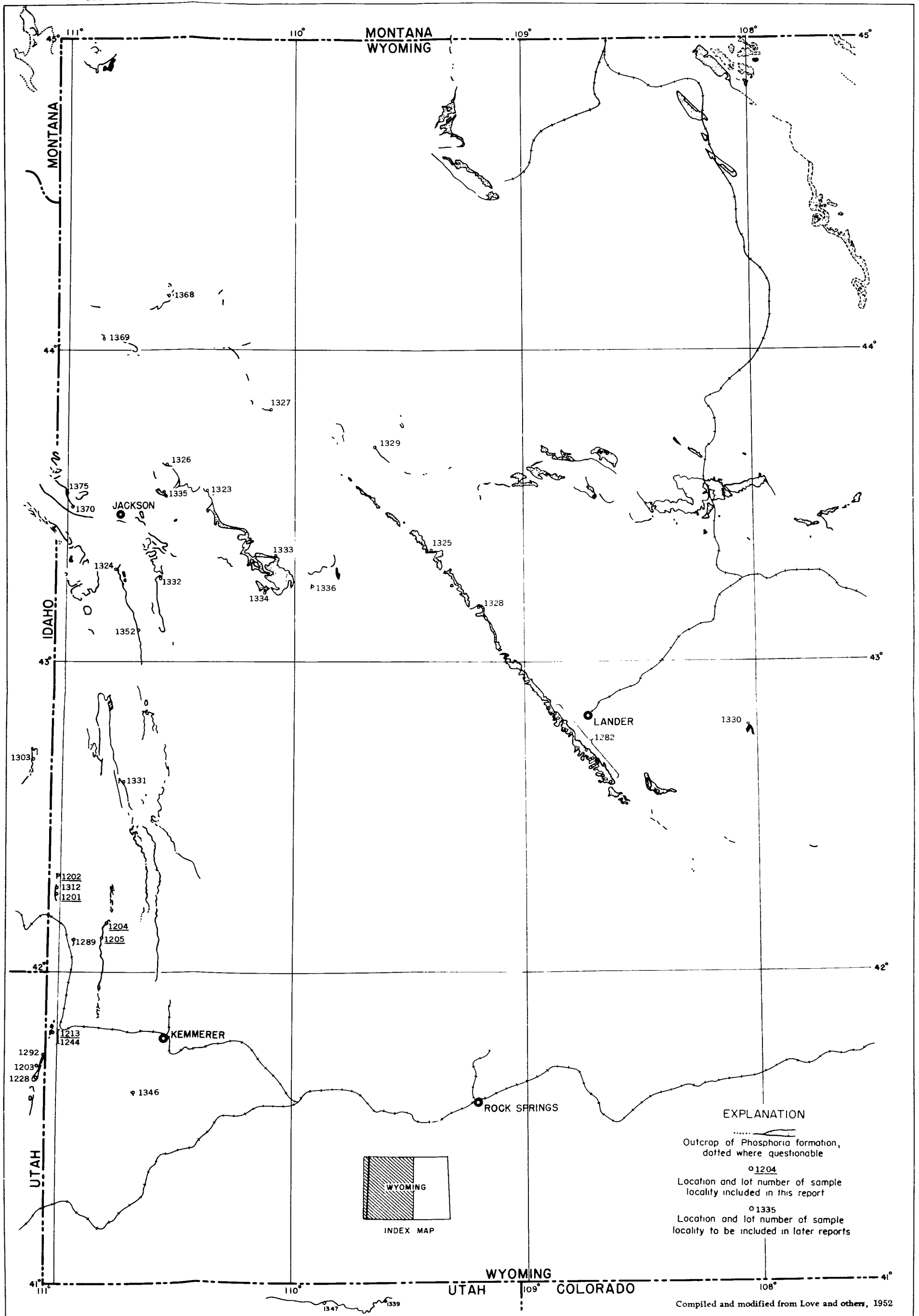
Washington, D. C., 1953  
Free on application to the Geological Survey, Washington 25 D. C.

## CONTENTS

	Lot no.	Page
Introduction.....		1
Acknowledgments.....		1
Stratigraphy of the Phosphoria formation in southwestern Wyoming.....		1
Stratigraphic sections.....		1
References.....		3
Tables of stratigraphic sections		
Layland Canyon.....	1202	5
Spectrographic analyses.....		9
Coal Canyon.....	1201	11
Additional analyses.....		16
Additional analyses of selected samples.....		20
Spectrographic analyses.....		21
North Fork of Pine Creek.....	1204	24
Spectrographic analyses.....		27
Middle Fork of Pine Creek.....	1205	28
Spectrographic analyses.....		32
Leefe.....	1213	33
Spectrographic analyses.....		35

## ILLUSTRATIONS

Plate 1. Phosphoria formation outcrops in Wyoming and localities sampled for phosphate.....	Faces 1
Figure 1. Generalized section of the Phosphoria formation at Coal Canyon.....	1201 2



PHOSPHORIA FORMATION OUTCROPS IN WYOMING AND LOCALITIES SAMPLED FOR PHOSPHATE

# STRATIGRAPHIC SECTIONS OF THE PHOSPHORIA FORMATION IN WYOMING, 1947-48

## INTRODUCTION

As part of a comprehensive investigation of the phosphate deposits of the western field begun in 1947, the U. S. Geological Survey has measured and sampled the Permian Phosphoria formation at many localities in Wyoming and adjacent states. Because these data will not be fully synthesized for many years, segments of the data, accompanied by little or no interpretation, will be published as preliminary reports as they are assembled. This report, which contains abstracts of some of the sections measured in western Wyoming (pl. 1), is one of this series. The field and laboratory procedures adopted in these investigations are described rather fully in a companion report (McKelvey and others, 1952a).

Many people have taken part in this investigation. R. M. Campbell, R. A. Gulbrandsen, R. A. Harris, D. M. Larrabee, F. W. O'Malley, O. A. Payne, R. S. Sears, R. P. Sheldon, and R. A. Smart participated in the description of the strata and the collection of the samples referred to in this report. D. B. Dimick, H. A. Larsen, and T. K. Rigby assisted in the preparation of exposures and the crushing and splitting of samples in the field. The laboratory preparation of samples for chemical analysis was done in Denver, Colo., under the direction of W. P. Huleatt.

Most of the  $P_2O_5$  and acid-insoluble analyses were made for the Survey by the U. S. Bureau of Mines at the Northwest Electrodevelopment Laboratory, Albany, Oreg., under the direction of S. M. Shelton and M. L. Wright. Most of the  $Al_2O_3$ ,  $Fe_2O_3$ , and loss-on-ignition analyses were made by the Trace Elements Section laboratory of the Survey in Washington, D. C., under the direction of J. C. Rabbitt by chemists I. Barlow, A. Cammerer, J. Greene, F. S. Grimaldi, N. Guttag, H. Levine, H. Mela, Jr., and R. G. Milkey, and most of the spectrographic reports were prepared in this laboratory by C. L. Waring. The samples from one locality (Coal Canyon) were analyzed for  $P_2O_5$ ,  $Al_2O_3$ ,  $Fe_2O_3$ ,  $V_2O_5$ , F, loss on ignition, and acid insoluble in the Chemical Laboratory of the Tennessee Valley Authority at Wilson Dam, Alabama, and spectrographically by D. M. Mortimer, of the Bureau of Mines at Albany.

Compilation of the data has been largely by R. P. Sheldon and F. D. Frieske under the supervision of R. W. Swanson. Organization of the tabular data has been largely by Anita Cozzetto.

## Acknowledgments

Special thanks are due W. W. Rubey, Helmuth Wedow, and J. Steele Williams, who contributed much in the way of advice and suggestions in planning and organization of the field program. The cost of both the field and laboratory investigations has been borne partly by the Division of Raw Materials of the Atomic Energy Commission. This support is gratefully acknowledged.

Many local residents, property owners, and phosphate companies furnished information and services and gave access to property. D. L. King of the San Francisco Chemical Company has been especially helpful in this regard.

## STRATIGRAPHY OF THE PHOSPHORIA FORMATION IN SOUTHWESTERN WYOMING

The Phosphoria formation in southwestern Wyoming consists of a lower phosphatic shale member, 95 to 145 feet in thickness, overlain by the Rex chert member, cherty limestone 65 to 145 feet in thickness, and capped by an upper shale member, 15 to 60 feet in thickness. It overlies the Pennsylvanian Wells formation and underlies the Triassic Dinwoody formation. Although the Wells formation consists largely of quartzose sandstone, calcareous in part, the upper 25 feet or more is dark gray limestone. It is equivalent to the upper member of the Wells formation in Idaho and may be the correlative of the lowermost member (A member) of the Phosphoria formation in Montana and northwestern Wyoming and the lower limestone member of the Park City formation in Utah (McKelvey, 1949). The Dinwoody formation consists of limestone, calcareous siltstone, and sandstone.

Most of the phosphatic layers are in the lower phosphatic shale member of the Phosphoria formation, but the upper shale member contains thin layers of phosphatic chert. The full thickness of the formation has been measured and sampled at Layland Canyon, Coal Canyon, and Middle Fork of Pine Creek. The phosphatic shale member contains many layers which persist, particularly in a north-south direction, over wide areas, but they may be grouped as shown in figure 1.

The correlation of the beds of the phosphatic shale member with those in adjacent parts of Idaho and Utah has already been discussed in preliminary fashion (McKelvey and others, 1952a and b) and will be considered more fully later. Suffice it to say here that whereas many of the layers throughout this member in western Wyoming may be identified in northern Utah, their identification in Idaho is uncertain except in the upper part of the member.

## STRATIGRAPHIC SECTIONS

Analytical data and abstracts of stratigraphic sections measured at five localities follow. Their locations, as well as the locations of others to be reported later, are shown in plate 1.

The semiquantitative spectrographic analyses made in the laboratories of both the Geological Survey and the Bureau of Mines are based upon comparisons with a standard plate representing known quantities of the elements tested for and made at the same exposure. Greater sensitivities for many elements can be obtained

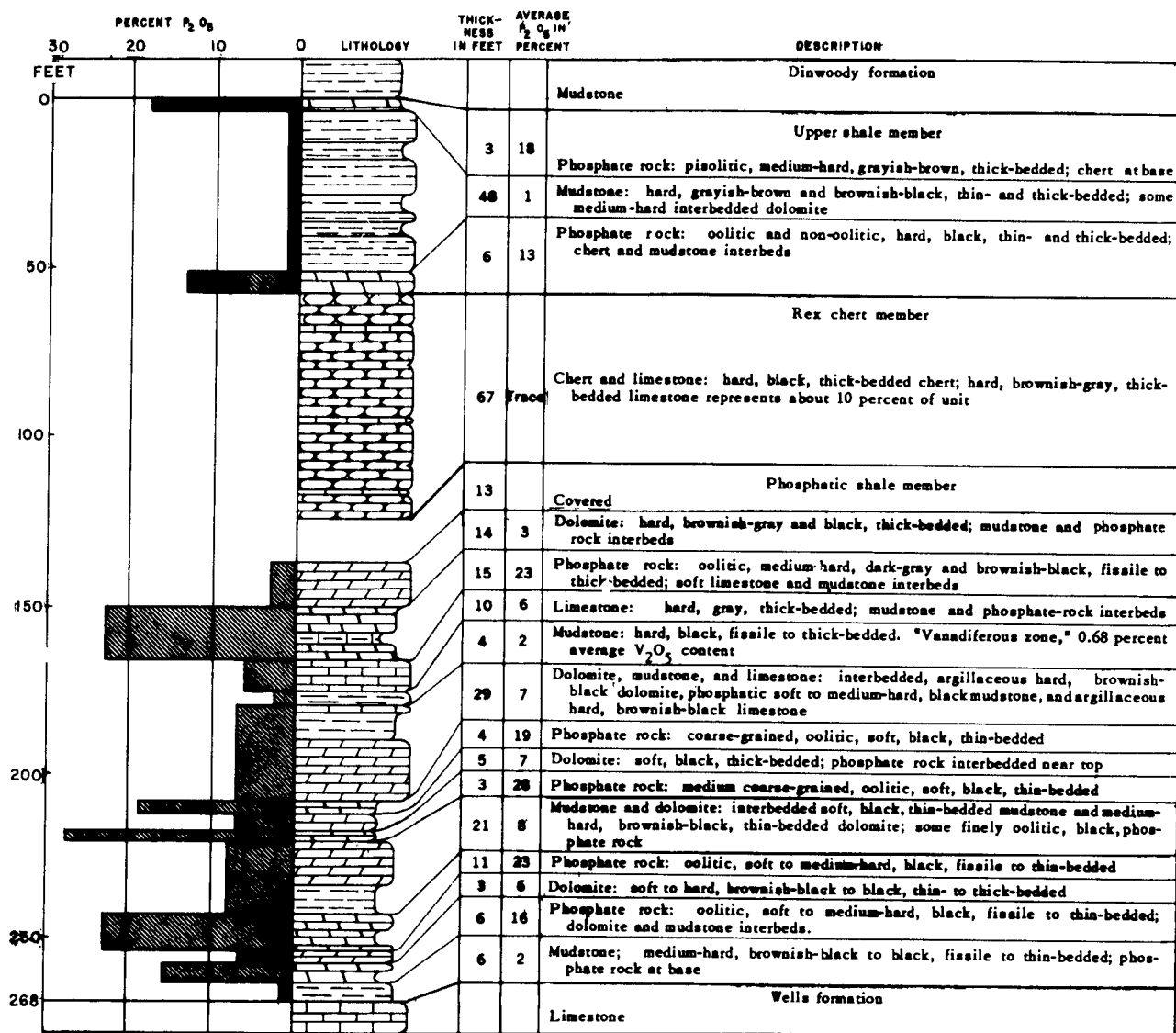


Figure 1. --Generalized section of the Phosphoria formation at Coal Canyon



by additional exposures. The standard sensitivities for the elements noted in this report are as follows:

Element	Percent	
	Geological Survey	Bureau of Mines
Al	0.0001	0.005
Sb	.001	.05
As	.1	.1
Ba	.001	.08
Be	.001	.001
Bi	.001	.002
B	.001	.001
Cd	.01	.1
Cs	1.0	--
Ca	.001	.01
Ce	.1	--
Cr	.001	.02
Co	.001	.01
Cb	.01	.01
Cu	.0001	.001
Dy	.01	--
Er	.01	--
F	.1*	--
Gd	.01	--
Ga	.01	.05
Ge	.001	.01
Au	--	.01
Hf	.1	--
In	.001	.05
Fe	.001	.005
La	.01	--
Pb	.01	.1
Li	.1	.2
Mg	.0001	.001
Mn	.001	.004
Hg	.1	.1
Mo	.001	.004
Na	.01	--
Ni	.001	.01
P	.1	--
Pt	.01	--
K	.1	--
Pr	.01	--
Re	.1	--
Rb	10.0	--
Sm	.1	--
Sc	.1	--
Si	.0001	.002
Ag	.001	.001
Na	.1	.05
Sr	.01	.1
Ta	.1	1.0
Tb	.1	--
Tl	.1	--
Th	.1	--
Sn	.01	.01
Ti	.001	.002
W	.1	.1
U	.1	--
V	.01	.01
Y	.001	--
Zn	.001	.05
Zr	.001	.003

\* A third exposure is required.

## REFERENCES

- Huleatt, William P., 1950, Automatic sample preparation saves time, money for U.S.G.S.: Eng. and Min. Jour., vol. 151, no. 6, pp. 62-67.
- McKelvey, V. E., 1949, Geological Studies of the western Phosphate field: Am. Inst. Min. Met. Eng. Mining Trans., vol. 184, pp. 270-279.
- McKelvey, V. E., Davidson, D. F., Sheldon, R. P., Hoppin, R. A., Campbell, R. M., and Weeks, R. A., 1952a, Stratigraphic sections of the Phosphoria formation in Idaho—first report: U. S. Geol. Survey Circular 208.
- McKelvey, V. E., Smith, L. E., Kinney, D. M., Huddle, J. W., Hosford, G. F., Sears, R. S., Sprouse, D. P., and Stewart, M. D., 1952b, Stratigraphic sections of the Phosphoria formation in Utah: U. S. Geol. Survey Circular 211.

LAYLAND CANYON, WYOMING. LOT NO. 1202.

Phosphatic shale member of Phosphoria formation sampled and upper shale member measured in hand trenches in Layland Canyon, sec. 19, and in next canyon to south, sec. 30, T. 27 N., R. 119 W., Lincoln County, Wyoming, on east limb of anticline. Beds P-1 through P-82 sampled in trench in lower shale member 300 feet above canyon bottom on north side of Layland Canyon; beds P-83 through R-1 sampled and upper shale member measured in trench 25 feet above canyon bottom on north side of canyon 1/4 mile to south. Beds in north trench strike N. 20° W. and dip 34° E. at Wells contact and strike N. 15° W. and dip 76° E. in upper part of section; beds in south trench strike N. 13° W. and dip 80° E. Phosphatic shale member measured by D. M. Larrabee, R. A. Hoppin, and L. E. Smith and sampled by R. P. Sheldon, R. A. Gulbrandsen, R. S. Sears, and O. A. Payne in June and July 1947; upper shale member measured by F. C. Armstrong in September 1947. Samples analyzed for P<sub>2</sub>O<sub>5</sub> and acid insoluble by U. S. Bureau of Mines Laboratory, Albany, Oregon, and for other constituents by Trace Elements Section Laboratory, U.S. Geological Survey, Washington, D. C.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)				Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition		
Dinwoody formation—basal bed only									
Td-1	Limestone, sandy	--	2.0	--	--	--	--	2.0	--
Upper shale member of Phosphoria formation									
U-12	Mudstone	--	0.7	--	--	--	--	0.7	--
U-11	Mudstone, contains phosphatic limestone concretion at base	--	0.8	--	--	--	--	1.5	--
U-10	Mudstone, calcareous, cherty	--	1.0	--	--	--	--	2.5	--
U-9	Mudstone	--	3.2	--	--	--	--	5.7	--
U-8	Mudstone	--	2.2	--	--	--	--	7.9	--
U-7	Mudstone	--	1.1	--	--	--	--	9.0	--
U-6	Mudstone, calcareous	--	0.75	--	--	--	--	9.75	--
U-5	Mudstone	--	1.4	--	--	--	--	11.15	--
U-4	Mudstone	--	0.35	--	--	--	--	11.50	--
U-3	Limestone, sandy	--	0.4	--	--	--	--	11.90	--
U-2	Phosphate rock, cherty	--	1.1	--	--	--	--	13.00	--
U-1	Phosphate rock, cherty	--	1.5	--	--	--	--	14.50	--
Rex chert member of the Phosphoria formation—basal beds only									
R-1	Chert, contains calcite veinlets	RAH-147-47	10.0	0.7	--	--	--	10.0	7.00
Phosphatic shale member of Phosphoria formation									
P-105	Limestone, argillaceous	RAH-148-47	6.0	1.7	--	--	--	33.5	10.20
P-104	Phosphate rock	RAH-149-47	0.3	24.0	--	--	--	19.4	17.40
P-103	Mudstone, contains phosphatic mudstone lens 0.2 foot thick	RAH-150-47	1.0	4.9	--	--	--	67.9	22.30
P-102	Mudstone	RAH-151-47	0.6	1.2	--	--	--	75.3	23.02
P-101	Mudstone, calcareous	RAH-152-47	2.6	0.5	--	--	--	49.5	24.32
P-100	Mudstone	RAH-153-47	1.8	4.2	--	--	--	70.2	31.88

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble		
P- 99	Phosphate rock	RAH- 154-47	1.5	24.8	2.4	4.47	6.8	18.6	13.8	69.08
P- 98	Phosphate rock and mudstone	RAH- 155-47	1.15	21.0	2.8	4.02	6.4	31.1	14.95	93.23
P- 97	Phosphate rock	RAH- 156-47	1.4	29.8	1.5	4.48	6.6	9.5	16.35	134.95
P- 96	Phosphate rock	RAH- 157-47	3.1	31.5	1.1	3.15	7.5	4.6	19.45	232.60
P- 95	Phosphate rock	RAH- 158-47	2.3	29.6	1.9	0.79	8.30	9.9	21.75	300.68
P- 94	Mudstone, phosphatic	RAH- 159-47	0.7	12.2	6.7	5.74	7.8	50.1	22.45	309.22
P- 93	Limestone, argillaceous	RAH- 160-47	2.2	0.3	4.5	4.45	16.8	40.2	24.65	309.88
P- 92	Phosphate rock	RAH- 161-47	1.1	29.6	2.1	3.82	8.0	9.0	25.75	342.44
P- 91	Phosphate rock, mudstone, and limestone	RAH- 162-47	1.2	20.6	3.9	1.04	9.50	26.1	26.95	367.16
P- 90	Phosphate rock	RAH- 163-47	2.3	28.4	2.5	3.76	7.0	11.7	29.25	432.48
P- 89	Phosphate rock, argillaceous	RAH- 164-47	1.2	20.6	5.3	4.24	6.5	31.5	30.45	457.20
P- 88	Phosphate rock	RAH- 165-47	2.1	30.1	2.4	4.86	5.1	11.5	32.55	520.41
P- 87	Mudstone, calcareous and phosphate rock	RAH- 166-47	1.0	9.3	5.4	5.58	15.4	40.3	33.55	529.71
P- 86	Mudstone, calcareous	RAH- 167-47	2.2	2.3	6.9	4.83	18.2	51.0	35.75	534.77
P- 85	Phosphate rock, calcareous and limestone	RAH- 168-47	0.5	20.8	2.5	4.89	17.6	6.1	36.25	545.17
P- 84	Mudstone, phosphatic	RAH- 169-47	1.5	13.7	9.0	6.22	13.8	36.3	37.75	565.72
P- 83	Limestone, "hanging-wall limestone"	RAH- 170-47	3.2	0.7	--	--	--	10.4	40.95	567.96
P- 82	Mudstone, phosphatic	LES- 258-47	0.3	8.9	--	--	--	52.3	41.25	570.63
P- 81	Mudstone	LES- 257-47	0.4	0.5	--	--	--	79.4	41.65	570.83
P- 80	Mudstone	LES- 256-47	0.65	0.4	--	--	--	64.1	42.30	571.09
P- 79	Mudstone	LES- 255-47	0.5	0.4	--	--	--	52.3	42.80	571.29
P- 78	Mudstone	LES- 254-47	0.5	0.6	--	--	--	74.1	43.30	571.59
P- 77	Mudstone	LES- 253-47	0.45	4.8	--	--	--	60.4	43.75	573.75
P- 76	Mudstone, phosphatic	LES- 252-47	0.4	8.4	--	--	--	53.7	44.15	577.11
P- 75	Limestone, argillaceous, "footwall limestone"	LES- 251-47	1.3	1.6	--	--	--	33.0	45.45	579.19
P- 74	Mudstone	LES- 250-47	0.4	3.3	--	--	--	75.0	45.85	580.51
P- 73	Mudstone, phosphatic	LES- 249-47	0.6	11.1	--	--	--	50.4	46.45	587.17
P- 72	Mudstone, calcareous	RAH- 139-47	1.6	0.7	--	--	--	66.6	48.05	588.29
P- 71	Mudstone, calcareous	RAH- 138-47	1.0	0.5	--	--	--	66.6	49.05	588.79
P- 70	Limestone, argillaceous	RAH- 137-47	2.2	0.6	--	--	--	41.5	51.25	590.11
P- 69	Mudstone, calcareous, phosphatic	RAH- 136-47	2.9	12.0	--	--	--	35.6	54.15	624.91
P- 68	Limestone, argillaceous	RAH- 135-47	0.5	2.5	--	--	--	36.3	54.65	626.16
P- 67	Mudstone, phosphatic	RAH- 134-47	0.7	14.9	--	--	--	42.1	55.35	636.59
P- 66	Limestone, argillaceous	RAH- 133-47	0.8	3.9	--	--	--	38.6	56.15	639.71
P- 65	Phosphate rock, argillaceous	RAH- 132-47	2.1	15.6	--	--	--	21.9	58.25	672.47
P- 64	Limestone, argillaceous, phosphatic	RAH- 131-47	0.8	9.7	--	--	--	31.4	59.05	680.23
P- 63	Phosphate rock, argillaceous	RAH- 129-47	3.5	17.1	--	--	--	24.7	62.55	740.08
--	Three limestone concretions in bed P-63	RAH- 130-47	(0.0-1.4)	2.0	--	--	--	1.8	--	--

P- 62	Phosphate rock, argillaceous	RAH- 128-47	0.7	17.6	--	--	--	25.1	63.25	752.40
P- 61	Phosphate rock, argillaceous	RAH- 127-47	1.7	17.5	--	--	--	24.9	64.95	782.15
P- 60	Limestone, argillaceous	RAH- 126-47	3.0	1.7	--	--	--	32.9	67.95	787.25
P- 59	Phosphate rock, argillaceous	RAH- 125-47	0.7	19.5	--	--	--	26.0	68.65	800.90
P- 58	Mudstone, calcareous, phosphatic	RAH- 124-47	0.4	10.2	--	--	--	45.7	69.05	804.98
P- 57	Phosphate rock, argillaceous, calcareous	RAH- 123-47	0.8	19.4	--	--	--	25.0	69.85	820.50
P- 56	Phosphate rock, argillaceous	RAH- 122-47	0.7	13.4	--	--	--	33.0	70.55	829.88
P- 55	Limestone, phosphatic, argillaceous	RAH- 121-47	2.5	10.5	--	--	--	21.1	73.05	856.13
P- 54	Phosphate rock and mudstone, calcareous	RAH- 120-47	1.6	14.9	--	--	--	17.0	74.65	879.97
P- 53	Limestone, phosphatic	RAH- 119-47	0.4	15.5	--	--	--	15.2	75.05	886.17
P- 52	Mudstone	RAH- 118-47	0.7	6.6	--	--	--	66.7	75.75	890.79
P- 51	Limestone	RAH- 117-47	0.7	7.4	--	--	--	7.4	76.45	895.97
P- 50	Phosphate rock	RAH- 116-47	0.6	28.7	--	--	--	9.4	77.05	913.19
P- 49	Limestone, argillaceous	RAH- 115-47	1.7	3.4	--	--	--	26.0	78.75	918.97
P- 48	Phosphate rock	RAH- 114-47	3.8	30.1	2.2	3.30	8.9	9.0	82.55	1,033.35
P- 47	Limestone, argillaceous, phosphatic	RAH- 113-47	2.0	10.4	--	--	--	28.2	84.55	1,054.14
P- 46	Mudstone, phosphatic, calcareous	RAH- 112-47	1.3	14.3	--	--	--	41.7	85.85	1,072.74
P- 45	Mudstone	RAH- 30-47	3.9	7.2	--	--	--	51.8	89.75	1,100.82
P- 44	Mudstone, calcareous	RAH- 29-47	2.1	2.5	--	--	--	46.3	91.85	1,106.07
P- 43	Mudstone, phosphatic, calcareous	RAH- 28-47	0.6	12.0	--	--	--	46.3	92.45	1,113.27
P- 42	Limestone, argillaceous	RAH- 27-47	3.1	6.5	--	--	--	28.0	95.55	1,133.42
P- 41	Phosphate rock, argillaceous	RAH- 26-47	0.5	23.0	--	--	--	26.5	96.05	1,144.92
P- 40	Phosphate rock	RAH- 25-47	0.6	27.7	--	--	--	15.7	96.65	1,161.54
P- 39	Mudstone, phosphatic	RAH- 24-47	1.0	9.7	--	--	--	46.2	97.65	1,171.24
P- 38	Mudstone, calcareous	RAH- 23-47	1.0	3.3	--	--	--	53.2	98.65	1,174.54
P- 37	Phosphate rock, argillaceous	RAH- 22-47	0.4	17.7	--	--	--	34.4	99.05	1,181.62
P- 36	Mudstone, phosphatic	RAH- 21-47	2.0	12.3	--	--	--	50.0	101.05	1,206.22
P- 35	Mudstone	RAH- 20-47	0.3	7.1	--	--	--	61.3	101.35	1,208.35
P- 34	Limestone	RAH- 19-47	1.6	2.0	--	--	--	18.6	102.95	1,211.55
P- 33	Phosphate rock, argillaceous	RAH- 18-47	0.5	25.6	3.7	4.32	8.6	20.0	103.45	1,224.35
P- 32	Phosphate rock	RAH- 17-47	0.7	25.6	3.6	3.76	9.7	19.0	104.15	1,242.27
P- 31	Phosphate rock, argillaceous	RAH- 16-47	0.2	18.1	4.5	4.28	11.3	34.0	104.35	1,245.89
P- 30	Phosphate rock, argillaceous	RAH- 15-47	1.1	19.1	3.3	3.54	11.6	26.6	105.45	1,266.90
P- 29	Phosphate rock	RAH- 14-47	1.2	31.4	1.8	4.56	6.4	9.8	106.65	1,304.58
P- 28	Phosphate rock	RAH- 13-47	2.1	30.8	1.7	3.78	6.6	10.3	108.75	1,369.26
P- 27	Phosphate rock	RAH- 12-47	0.4	29.8	2.1	4.62	7.1	10.0	109.15	1,381.18
P- 26	Phosphate rock	RAH- 11-47	0.6	30.4	2.2	3.92	6.8	10.5	109.75	1,399.42
P- 25	Phosphate rock	RAH- 10-47	0.8	26.0	3.6	3.94	8.4	18.7	110.55	1,420.22
P- 24	Phosphate rock	RAH- 9-47	0.3	27.9	2.6	3.92	8.2	13.4	110.85	1,428.59
P- 23	Phosphate rock	RAH- 8-47	0.3	26.4	2.6	3.12	7.8	18.8	111.15	1,436.51
P- 22	Phosphate rock, argillaceous	RAH- 7-47	0.2	22.1	2.2	2.88	7.6	28.4	111.35	1,440.93
P- 21	Phosphate rock, argillaceous	RAH- 6-47	0.4	19.3	3.2	5.26	7.9	19.7	111.75	1,448.65
P- 20	Limestone, argillaceous	RAH- 5-47	1.0	6.4	4.4	4.54	23.0	33.3	112.75	1,455.05
P- 19	Mudstone, phosphatic, calcareous	RAH- 4-47	0.4	11.9	6.2	4.80	12.4	42.3	113.15	1,459.81

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble		
P-18	Phosphate rock, argillaceous	RAH- 3-47	0.7	22.6	4.2	3.90	7.0	22.0	113.85	1,475.63
P-17	Limestone, argillaceous, phosphatic	RAH- 2-47	1.1	10.3	5.5	5.26	18.0	32.7	114.95	1,486.96
P-16	Phosphate rock, argillaceous	RAH- 1-47	0.4	20.8	6.5	5.80	9.4	24.5	115.35	1,495.28
P-15	Dolomite, calcareous	DML- 24-47	1.1	3.9	--	--	--	13.7	116.45	1,499.57
P-14	Mudstone, cherty	DML- 23-47	0.1	2.7	--	--	--	80.9	116.55	1,499.84
P-13	Limestone, argillaceous	DML- 22-47	0.7	1.7	--	--	--	26.6	117.25	1,501.03
P-12	Phosphate rock	DML- 21-47	1.3	23.9	--	--	--	19.4	118.55	1,532.10
P-11	Phosphate rock, calcareous, contains fluorite	DML- 20-47	2.3	20.4	--	--	--	15.2	120.85	1,579.02
P-10	Mudstone, phosphatic	DML- 19-47	0.2	13.8	--	--	--	42.1	121.05	1,581.78
P-9	Limestone, argillaceous	DML- 18-47	1.4	3.2	--	--	--	23.6	122.45	1,586.26
P-8	Phosphate rock, argillaceous	DML- 17-47	0.1	21.8	--	--	--	24.6	122.55	1,588.44
P-7	Phosphate rock, argillaceous	DML- 16-47	0.3	25.4	--	--	--	20.1	122.85	1,596.06
P-6	Mudstone	DML- 15-47	0.3	2.9	--	--	--	67.0	123.15	1,596.93
P-5	Mudstone, calcareous	DML- 14-47	3.2	0.4	--	--	--	68.6	126.35	1,598.21
P-4	Mudstone	DML- 13-47	0.5	0.2	--	--	--	76.2	126.85	1,598.31
P-3	Mudstone	DML- 12-47	2.5	0.4	--	--	--	81.0	129.35	1,599.31
P-2	Phosphate rock	DML- 11-47	0.3	33.4	--	--	--	5.2	129.65	1,609.33
P-1	Phosphate rock	DML- 10-47	0.4	34.8	--	--	--	3.3	130.05	1,623.25

Wells formation — not measured

Cw-1	Mudstone, calcareous and limestone	--	--	--	--	--	--	--	--	--
------	------------------------------------	----	----	----	----	----	----	----	----	----

SPECTROGRAPHIC ANALYSES—LAYLAND CANYON, WYOMING. LOT NO. 1202.

Semi-quantitative analyses of samples of the Phosphoria formation, Layland Canyon, Wyoming (see immediately preceding pages for location of section, thickness and description of strata, and chemical analyses of samples), made by U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch, Washington, D. C. In addition to the elements listed in the table below, Sb, As, Be, Bi, Ce, Cs, Co, Cb, Ge, In, Hg, Nd, Pt, Re, Rb, Sc, Ta, Tl, Th, and W were looked for in all samples but were not detected.

Explanation of symbols

A = more than 10 percent      F = 0.001-0.01 percent  
 B' = 1-10 percent<sup>1</sup>      G = less than 0.001 percent  
 D = 0.1-1 percent      ND = not detected  
 E = 0.01-0.1 percent

Bed no.	Sample no.	Al	Ba	B	Cd	Ca	Cr	Cu	Fe	La	Pb	Mg	Mn	Mo	Ni	P	Si	Ag	Na	Sr	Sn	Ti	V	Y	Zn	Zr
Beds P-105 through P-100 not analyzed.																										
P-99	RAH-154-47	B'	F	F	F	A	E	F	B'	E	E	D	E	F	E	A	B'	G	D	D	F	E	D	E	E	F
P-98	RAH-155-47	B'	E	F	F	A	E	F	B'	E	E	D	E	F	E	A	B'	G	D	D	F	E	D	E	E	F
P-97	RAH-156-47	B'	D	F	F	A	E	F	B'	E	E	D	E	F	E	A	B'	G	D	D	F	E	D	E	E	F
P-96	RAH-157-47	B'	F	F	F	A	E	F	B'	E	E	D	E	F	E	A	B'	G	D	D	F	E	D	E	E	F
P-95	RAH-158-47	B'	F	F	E	A	E	E	B'	F	E	D	E	F	E	A	B'	G	D	D	F	E	D	E	E	F
P-94	RAH-159-47	B'	E	F	F	B'	D	E	B'	E	E	D	E	F	E	B'	A	G	E	D	D	F	D	E	E	F
P-93	RAH-160-47	B'	F	F	F	B'	E	F	B'	ND	F	B'	E	F	E	D	A	G	E	D	D	F	D	E	E	F
P-92	RAH-161-47	B'	F	F	F	A	D	F	B'	E	F	D	E	F	F	A	B'	G	E	D	D	F	D	E	E	F
P-91	RAH-162-47	B'	F	F	F	A	D	F	B'	E	F	D	E	F	F	A	B'	G	E	D	D	ND	E	E	E	F
P-90	RAH-163-47	B'	F	F	F	A	D	F	B'	E	E	D	E	F	E	A	B'	G	E	D	D	F	D	E	E	F
P-89	RAH-164-47	B'	F	F	F	A	D	E	B'	E	E	D	E	F	E	A	B'	G	E	D	D	F	D	E	E	F
P-88	RAH-165-47	B'	F	F	ND	A	D	F	B'	E	E	D	E	F	E	A	B'	G	E	D	D	F	D	E	E	F
P-87	RAH-166-47	B'	F	F	F	B'	D	F	B'	E	E	D	E	F	E	B'	A	G	E	D	D	F	D	E	E	F
P-86	RAH-167-47	B'	F	F	F	B'	D	F	B'	E	F	B'	E	F	E	B'	A	G	E	D	D	F	D	E	E	F
P-85	RAH-168-47	B'	F	F	F	A	D	F	B'	E	F	D	E	F	E	A	B'	G	ND	D	F	E	E	E	E	F
P-84	RAH-169-47	B'	E	F	F	B'	D	E	B'	E	E	D	E	F	E	B'	A	G	E	D	D	F	D	E	E	F
Beds P-83 through P-49 not analyzed.																										
P-48	RAH-114-47	B'	E	F	F	A	E	E	B'	E	E	D	F	F	E	A	B'	G	D	D	F	E	D	E	E	F
Beds P-47 through P-34 not analyzed.																										
P-33	RAH-18-47	B'	F	F	E	A	E	E	B'	E	E	D	F	F	ND	A	B'	G	E	D	D	F	E	D	E	F
P-32	RAH-17-47	B'	F	F	E	A	E	E	B'	E	E	D	F	F	E	A	B'	G	E	D	D	F	E	D	E	F
P-31	RAH-16-47	B'	F	F	E	A	E	E	B'	E	E	D	F	F	E	A	B'	G	E	D	D	F	E	D	E	F
P-30	RAH-15-47	B'	F	F	E	A	E	E	B'	E	E	D	F	F	E	A	B'	G	E	D	D	F	E	D	E	F
P-29	RAH-14-47	B'	E	F	E	A	E	F	B'	E	E	D	F	F	E	A	B'	G	E	D	D	F	E	D	E	F

<sup>1</sup> B' is equivalent to B and C of Bureau of Mines analyses.

Bed no.	Sample no.	Al	Ba	B	Cd	Ca	Cr	Cu	Fe	La	Pb	Mg	Mn	Mo	Ni	P	Si	Ag	Na	Sr	Sn	Ti	V	Y	An	Zr
P-28	RAH- 13-47	B'	F	F	E	A	E	F	B'	F	E	D	F	F	E	A	B'	G	D	D	F	E	D	E	E	F
P-27	RAH- 12-47	B'	E	F	E	A	D	E	B'	F	F	D	F	F	F	A	B'	G	D	E	F	E	D	F	E	F
P-26	RAH- 11-47	B'	E	F	E	A	D	E	B'	F	F	D	E	F	F	A	B'	G	D	E	F	E	D	F	E	F
P-25	RAH- 10-47	B'	E	F	E	A	D	E	B'	F	F	D	E	E	F	A	B'	G	D	E	F	E	D	F	E	F
P-24	RAH- 9-47	B'	E	F	E	A	D	E	B'	F	F	D	E	E	F	A	B'	G	D	E	F	E	D	F	E	F
P-23	RAH- 8-47	B'	E	F	E	A	D	E	B'	ND	F	D	E	E	F	A	B'	G	D	E	F	E	D	F	E	F
P-22	RAH- 7-47	B'	E	F	E	A	D	E	B'	F	F	B'	E	E	F	A	B'	G	D	E	F	E	D	F	E	F
P-21	RAH- 6-47	B'	E	F	E	A	D	E	B'	F	F	D	E	F	F	A	B'	G	D	E	F	E	D	F	E	F
P-20	RAH- 5-47	B'	E	F	E	A	D	E	B'	ND	F	B'	E	E	F	A	B'	G	D	E	ND	E	D	F	E	F
P-19	RAH- 4-47	B'	E	F	E	A	D	E	B'	F	F	B'	E	F	F	A	B'	G	D	E	F	E	D	F	E	F
P-18	RAH- 3-47	B'	E	F	E	A	D	E	B'	F	E	D	E	E	F	A	B'	G	D	E	F	E	D	E	F	F
P-17	RAH- 2-47	B'	E	F	E	A	D	E	B'	F	E	B'	E	E	F	A	B'	G	D	E	F	E	D	F	E	F
P-16	RAH- 1-47	B'	E	F	E	A	D	E	B'	F	E	B'	E	F	F	A	B'	G	D	E	F	E	E	F	E	F
Beds P-15 through P-1 not analyzed.																										

COAL CANYON, WYOMING. LOT NO. 1201.

Phosphoria formation sampled in hand trenches, mine adit, and natural exposures in Coal Canyon, sec. 7, T. 26 N., R. 119 W., Lincoln County, Wyoming, on east limb of Sublette anticline. Upper shale member sampled in trench 200 feet above canyon bottom on south side; Rex chert member in natural exposures 50 feet above canyon bottom on south side; beds P-69 to P-74 from vanadiferous zone in face of adit 50 feet above canyon bottom on north side; all other beds from trench in phosphatic shale member at bottom of canyon on south side. Beds strike north and dip 75° E. Section measured by V. E. McKelvey, D. M. Larrabee, and L. E. Smith and sampled by R. A. Gulbrandsen; samples 2058-2087 collected in June 1946, all others in June 1947. Samples analyzed by Tennessee Valley Authority.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)							Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	V <sub>2</sub> O <sub>5</sub>	F	Loss on ignition	Acid insoluble		
Dinwoody formation—basal bed only												
Td - 1	Mudstone	VEM-97-47	1.7	0.13	11.7	3.0	0.07	0.09	9.7	74.9	1.7	1.70
Upper shale member of Phosphoria formation												
U- 27	Phosphate rock, argillaceous	VEM-96-47	1.7	24.8	4.3	3.4	0.07	2.5	4.9	23.8	1.7	42.16
U- 26	Phosphate rock and chert	VEM-95-47	0.6	15.14	9.1	4.2	--	1.3	6.7	42.10	2.3	51.24
U- 25	Chert, dolomitic	VEM-94-47	0.8	6.25	3.8	2.2	0.05	0.68	15.3	46.8	3.1	56.24
U- 24	Mudstone and chert	VEM-93-47	4.0	0.70	5.3	3.2	0.04	0.13	4.3	81.3	7.1	59.04
U- 23	Mudstone, cherty	VEM-92-47	1.6	1.65	5.4	3.8	0.04	0.18	2.5	85.9	8.7	61.68
U- 22	Mudstone	VEM-91-47	1.6	2.93	11.2	4.9	0.09	0.34	6.1	77.1	10.3	66.37
U- 21	Mudstone	VEM-90-47	3.2	4.60	10.7	4.5	0.06	0.58	7.5	70.3	13.50	81.09
U- 20	Mudstone	VEM-89-47	3.0	4.00	11.7	4.3	0.10	0.47	7.2	73.0	16.5	93.09
U- 19	Mudstone	VEM-88-47	2.6	2.00	7.3	2.5	0.10	0.31	9.5	72.1	19.1	98.29
U- 18	Mudstone, calcareous	VEM-87-47	2.6	0.30	7.8	2.6	0.06	0.21	11.7	69.2	21.7	99.07
U- 17	Limestone, argillaceous	VEM-86-47	1.6	0.5	3.6	1.5	0.04	0.11	24.3	43.5	23.3	99.87
U- 16	Mudstone	VEM-85-47	3.5	1.39	7.3	2.5	0.05	0.18	10.6	68.5	26.8	104.74
U- 15	Mudstone	VEM-84-47	3.9	1.01	4.5	2.3	0.04	0.16	11.8	68.0	30.7	108.69
U- 14	Mudstone	VEM-83-47	3.7	0.25	8.7	2.8	0.08	0.19	7.5	80.3	34.4	109.60
U- 13	Mudstone	VEM-82-47	3.6	1.21	8.1	3.2	0.05	0.24	7.1	76.8	38.0	133.96
U- 12	Mudstone	VEM-81-47	4.3	0.85	10.4	3.5	0.08	0.26	8.6	75.00	42.3	117.60
U- 11	Mudstone	VEM-80-47	1.4	0.60	10.3	4.0	0.04	0.26	8.6	73.4	43.7	118.45
U- 10	Mudstone, dolomitic	VEM-79-47	1.0	1.60	6.4	2.9	0.08	0.11	14.1	64.4	44.7	120.05
U- 9	Mudstone	VEM-78-47	0.7	0.91	9.8	4.7	0.05	0.17	5.8	79.5	45.4	120.69
U- 8	Mudstone	VEM-77-47	2.7	1.00	10.4	3.9	0.05	0.22	4.9	85.2	48.1	123.39
U- 7	Mudstone	VEM-76-47	3.1	-0.75	7.5	3.2	0.05	0.22	5.2	82.5	51.2	125.71
U- 6	Phosphate rock, cherty	VEM-75-47	2.3	22.5	3.7	3.3	0.06	2.1	6.7	25.8	53.50	177.46
U- 5	Mudstone	VEM-74-47	1.4	4.1	5.1	3.5	0.04	0.51	4.4	73.2	54.9	183.20
U- 4	Chert	VEM-73-47	0.6	0.49	2.4	2.6	0.04	0.10	7.6	77.6	55.5	183.50
U- 3	Chert	VEM-72-47	1.1	4.71	1.5	3.2	0.03	0.54	6.0	69.6	56.6	188.68
U- 2	Phosphate rock, cherty	VEM-71-47	0.6	25.5	1.4	2.0	0.04	2.4	3.4	25.1	57.2	203.98
U- 1	Phosphate rock, argillaceous	VEM-70-47	0.4	16.7	4.4	2.8	0.11	2.1	4.9	30.6	57.6	210.66



Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)						Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative) <sup>5</sup>
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	V <sub>2</sub> O <sub>5</sub>	F	Loss on ignition		
Rex chert member of Phosphoria formation											
	Chert and limestone, represents top of VEM-68-47 resampled in upper shale trench	VEM-69-47	(1.4)	0.65	0.7	1.8	--	0.08	15.3	61.5	--
R- 7	Chert and limestone	VEM-68-47	8.5	0.11	0.2	2.5	--	0.05	9.6	73.0	0.94
R- 6	Chert and limestone	VEM-67-47	9.0	0.22	0.4	1.9	--	0.03	10.2	73.8	2.92
R- 5	Chert and limestone	VEM-66-47	10.5	0.20	0.5	2.1	--	0.04	13.1	66.7	5.02
R- 4	Chert and limestone	VEM-65-47	9.0	0.23	0.3	2.2	--	0.04	9.6	72.3	7.09
R- 3	Chert and limestone; fos. col. no. 47-HW-48	VEM-64-47	10.4	0.20	0.7	2.3	--	0.04	11.6	68.5	9.17
R- 2	Chert and limestone	VEM-63-47	9.8	0.40	0.8	2.3	--	0.05	11.2	69.2	13.09
R- 1	Chert and limestone; fos. col. no. 47-HW-49	VEM-62-47	9.6	0.25	0.4	1.9	--	0.05	14.4	63.8	15.49
Phosphatic shale member of Phosphoria formation											
--	Covered	--	13	--	--	--	--	--	--	--	--
P-107	Dolomite, calcareous, argillaceous	DML- 9-47	5.7	0.76	2.5	0.9	0.04	0.13	35.7	20.0	4.33
P-106	Phosphate rock	DML- 8-47	0.3	25.45	4.1	1.5	0.05	2.5	6.2	17.8	11.97
P-105	Mudstone; fos. col. no. 47-HW-46	DML- 7-47	0.4	3.25	13.3	4.0	0.07	0.37	5.9	75.6	13.27
P-104	Mudstone	DML- 6-47	0.5	6.15	10.9	3.1	0.06	0.59	6.3	68.8	16.35
P-103	Mudstone	DML- 5-47	0.5	4.35	12.1	3.4	0.04	0.48	6.3	73.3	18.53
P-102	Mudstone, dolomitic	DML- 4-47	3.2	0.65	9.3	3.0	0.02	0.15	13.7	66.9	20.61
P-101	Mudstone	DML- 3-47	1.2	4.51	10.2	3.3	0.04	0.52	7.7	69.3	26.02
P-100	Phosphate rock; fos. col. no. 47-HW-45	DML- 2-47	0.4	25.9	3.6	1.1	0.04	2.4	6.5	19.0	36.38
P- 99	Dolomite, argillaceous; fos. col. no. 47-HW-44	DML- 1-47	1.4	0.81	4.3	1.5	0.06	0.15	28.3	35.6	37.51
P- 98	Phosphate rock	2063 <sup>2</sup>	1.1	29.8	1.4	0.8	0.07	3.1	6.2	8.2	70.29
P- 97	Phosphate rock	2062 <sup>2</sup>	1.9	32.9	0.9	0.6	0.10	3.8	5.4	3.2	132.80
P- 96	Phosphate rock	2061 <sup>2</sup>	0.7	27.2	2.3	1.1	0.23	2.9	8.6	12.4	30.3
P- 95	Phosphate rock	2060	0.6	29.8	1.5	0.7	0.26	3.1	8.0	7.2	151.84
P- 94	Phosphate rock	2059	0.5	26.9	2.1	1.0	0.24	2.7	9.6	11.4	169.72
P- 93	Phosphate rock	2058	0.8	32.7	1.2	0.5	0.15	3.4	6.9	5.2	183.17
P- 92	Phosphate rock, argillaceous	VEM-61-47	1.1	21.6	4.2	1.7	0.16	2.2	9.0	22.2	209.33
P- 91	Mudstone, dolomitic	VEM-60-47	0.4	3.80	7.8	2.6	0.09	0.51	13.5	58.5	233.09
P- 90	Limestone, argillaceous, dolomitic	VEM-59-47	1.9	0.20	3.4	2.0	0.08	0.12	26.6	38.6	234.61
P- 89	Phosphate rock	VEM-58-47	0.7	29.3	2.0	2.3	0.10	3.0	9.5	10.6	234.99
P- 88	Phosphate rock, calcareous, contains limestone lens										255.50
P- 87	0.0-0.3 foot thick Phosphate rock, argillaceous	VEM-57-47 VEM-56-47	0.9 0.6	24.09 21.03	0.8 4.4	0.8 1.6	0.06 0.11	2.6 1.9	15.0 8.3	4.7 29.2	277.18 289.80

P- 86	Phosphate rock	VEM-55-47	0.5	27.45	2.1	1.2	0.06	2.9	8.1	13.9	38.3	303.52
P- 85	Phosphate rock	VEM-54-47	0.9	27.44	1.4	1.1	0.06	3.0	8.1	11.3	39.2	328.22
P- 84	Phosphate rock and phosphatic mudstone	VEM-53-47	1.8	16.52	5.3	1.9	0.05	1.6	9.5	40.4	41.0	357.96
P- 83	Phosphate rock, limestone, and mudstone	VEM-52-47	1.0	29.41	2.3	1.7	0.05	3.2	5.4	11.80	42.0	387.37
P- 82	Limestone, argillaceous; fos. col. no. 47-HW-43	VEM-51-47	1.7	2.11	5.8	2.1	0.06	0.24	22.1	41.2	43.7	390.96
P- 81	Mudstone, calcareous and phosphatic	VEM-50-47	2.0	4.04	8.8	2.5	0.05	0.45	14.2	56.8	45.7	399.04
P- 80	Limestone, argillaceous, mudstone, and phosphate rock	VEM-49-47	1.0	9.90	6.7	2.3	0.09	1.1	16.8	37.0	46.7	408.94
P- 79	Mudstone, calcareous	VEM-48-47	0.8	2.16	9.7	3.0	0.05	0.31	16.5	54.7	47.5	410.67
P- 78	Phosphate rock	VEM-47-47 <sup>2</sup>	0.4	28.67	1.9	2.1	0.11	2.8	13.1	5.62	47.9	422.14
P- 77	Limestone, argillaceous, calcareous mudstone, and phosphate rock	VEM-46-47	2.1	9.92	6.2	2.6	0.07	1.1	22.0	25.2	50.0	442.97
P- 76	Limestone, "hanging-wall limestone"; fos. col. no. 47-HW-42	VEM-45-47	1.6	0.36	1.1	0.5	0.06	0.06	41.1	5.90	51.6	443.55
P- 75	Mudstone	VEM-44-47	0.75	2.73	8.6	3.4	0.52	0.44	16.7	59.32	52.35	445.60
P- 74	Mudstone	VEM-43-47	0.4	0.34	9.8	3.9	1.75	0.15	24.9	51.2	52.75	445.74
P- 73	Mudstone	VEM-42-47	0.65	0.20	9.6	4.0	1.45	0.23	22.6	56.38	53.40	445.87
P- 72	Mudstone	VEM-41-47	0.9	0.05	9.7	4.4	0.37	0.08	16.6	65.75	54.30	445.91
P- 71	Mudstone	VEM-40-47	1.05	6.30	7.1	3.3	0.14	0.67	17.4	46.66	55.35	452.53
P- 70	Limestone, argillaceous, "footwall limestone"; fos. col. no. 47-HW-35	VEM-39-47	1.1	0.80	2.6	1.2	0.06	0.10	30.7	27.6	56.45	453.41
P- 69	Mudstone, phosphatic	VEM-38-47	1.5	8.31	9.2	3.6	0.08	0.80	10.3	57.9	57.95	465.87
P- 68	Mudstone	VEM-37-47	1.4	0.76	9.3	2.8	0.08	0.09	11.4	73.0	59.35	466.93
P- 67	Mudstone	VEM-36-47	0.5	6.02	10.3	3.4	0.06	0.57	10.2	65.1	59.85	469.94
P- 66	Mudstone, calcareous, dolomitic	VEM-35-47	2.3	0.66	5.7	1.9	0.05	0.08	25.9	41.4	62.15	471.46
P- 65	Mudstone, phosphatic, and calcareous phosphatic mudstone	VEM-34-47	3.0	9.97	8.0	2.6	0.03	1.1	14.3	42.4	65.15	501.37
P- 64	Dolomite, argillaceous	VEM-33-47	0.7	1.51	5.9	1.9	0.05	0.18	25.7	39.9	65.85	502.43
P- 63	Mudstone, phosphatic	VEM-32-47	2.0	12.38	8.5	2.6	0.08	1.3	15.9	35.23	67.85	527.19
P- 62	Phosphate rock, argillaceous	VEM-31-47	2.0	13.73	5.1	2.1	0.17	1.4	18.7	25.1	69.85	554.65
P- 61	Limestone, dolomitic	VEM-30-47	3.5	0.69	4.3	1.4	0.05	0.09	33.1	15.00	73.35	557.07
P- 60	Dolomite, argillaceous	VEM-29-47	1.1	2.22	3.6	1.3	0.05	0.22	33.7	23.4	74.45	559.51
P- 59	Phosphate rock, dolomitic, argillaceous, dolomite lens included in sample	VEM-28-47	3.0	14.29	7.1	2.3	0.08	1.3	18.2	26.53	77.45	602.38
P- 58	Dolomite	VEM-27-47	1.6	2.10	2.2	0.7	0.07	0.22	40.7	10.47	79.05	605.74
P- 57	Mudstone, phosphatic	VEM-26-47	1.6	13.63	10.5	3.1	0.05	1.5	15.2	38.27	80.65	627.55
P- 56	Dolomite, argillaceous	VEM-25-47	1.2	2.24	2.2	0.7	0.05	0.27	40.0	25.48	81.85	630.24

<sup>1</sup> Fossil collection made by H. Wedow, Paleontology and Stratigraphy Branch, U. S. Geological Survey.

<sup>2</sup> See additional analyses of selected samples at end of chemical analyses tables.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)						Loss on ignition	Acid insoluble	Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	V <sub>2</sub> O <sub>5</sub>	F					
P-55	Phosphate rock, dolomitic	VEM-24-47	1.6	14.85	4.3	1.4	0.21	1.5		22.4	15.28	83.45	654.00
P-54	Dolomite	VEM-23-47	1.3	5.38	1.3	0.9	0.04	0.56		35.9	10.8	84.75	660.99
P-53	Phosphate rock and phosphatic mudstone	VEM-22-47	2.5	21.00	4.5	1.7	0.09	2.1		18.9	11.68	87.25	713.49
P-52	Dolomite, phosphatic	VEM-21-47	0.7	8.11	0.1	0.5	0.07	0.78		35.8	4.93	87.95	719.17
P-51	Phosphate rock	VEM-20-47	0.3	24.35	2.8	1.7	0.08	2.6		11.9	16.55	88.25	726.47
P-50	Dolomite	VEM-19-47	1.3	4.42	3.0	1.1	0.06	0.47		34.8	18.02	89.55	732.22
Fault (strikes N. 10° W. dips 60° E.) truncates beds P-50 and P-51.													
P-49	Phosphate rock	VEM-18-47	0.6	26.01	3.1	1.4	0.06	2.9		11.2	10.08	90.15	747.83
P-48	Dolomite	VEM-17-47	1.1	4.04	1.7	1.0	0.07	0.44		37.0	13.63	91.25	752.27
P-47	Dolomite	VEM-16-47	1.1	3.05	1.7	0.9	0.09	0.35		38.7	12.92	92.35	755.63
P-46	Dolomite, argillaceous	VEM-15-47	1.1	4.85	3.7	1.7	0.08	0.56		30.5	23.8	93.45	760.97
P-45	Phosphate rock	VEM-14-47	0.8	28.85	1.3	0.9	0.08	3.3		11.0	3.46	94.25	784.05
P-44	Phosphate rock	LES-10-47	1.3	26.24	2.3	1.2	0.25	2.9		13.6	10.0	95.55	818.11
P-43	Phosphate rock	LES-9-47	0.7	29.26	1.2	1.0	0.13	3.2		8.7	8.9	96.25	838.59
P-42	Dolomite	LES-8-47	2.0	4.41	2.0	0.8	0.05	0.44		33.7	17.8	98.25	847.41
P-41	Mudstone, phosphatic	LES-7-47	3.8	10.75	7.9	2.5	0.05	1.1		11.7	48.2	102.05	888.26
P-40	Mudstone, dolomitic	LES-6-47	3.0	1.55	4.6	2.1	0.05	0.19		22.5	47.4	105.05	892.91
P-39	Mudstone, phosphatic	LES-5-47	0.6	12.33	8.5	2.5	0.07	1.1		10.2	47.2	105.65	900.31
P-38	Dolomite, argillaceous	LES-4-47	1.8	1.90	2.2	0.9	0.04	0.21		31.5	28.7	107.45	903.73
P-37	Dolomite, argillaceous	LES-3-47	0.6	4.75	2.3	0.8	0.05	0.50		27.6	29.2	108.05	906.58
P-36	Dolomite, argillaceous	LES-2-47	0.9	7.08	2.4	0.8	0.05	0.75		24.7	28.8	108.95	912.95
P-35	Phosphate rock, argillaceous	LES-1-47	0.4	23.34	3.7	1.3	0.06	2.3		8.2	25.2	109.35	922.29
P-34	Phosphate rock	VEM-13-47	0.6	30.00	1.8	0.7	0.09	3.2		7.6	9.4	109.95	940.29
P-33	Mudstone and phosphate rock, contains gypsum	2086	0.8	8.1	3.0	2.6	0.35	0.83		19.6	48.9	110.75	946.77
P-32	Mudstone, dolomitic	2085	1.8	7.2	2.2	2.0	--	0.71		19.1	41.1	112.55	959.73
P-31	Phosphate rock, argillaceous	2084	1.0	18.1	2.0	1.8	0.42	1.8		11.6	33.3	113.55	977.83
P-30	Mudstone, phosphatic	2083	0.9	8.0	2.5	2.2	--	0.84		13.4	49.5	114.45	985.03
P-29	Mudstone, dolomitic	2082	0.8	6.0	2.4	1.9	0.23	0.88		16.6	40.2	115.25	989.83
P-28	Dolomite, argillaceous	2081	1.7	6.4	1.3	1.2	0.18	0.71		25.7	25.5	116.95	1,000.71
P-27	Phosphate rock	2080 <sup>2</sup>	1.2	26.3	2.1	1.1	0.30	2.4		9.4	14.6	118.15	1,032.27
P-26	Phosphate rock	2079 <sup>2</sup>	2.1	26.1	1.6	0.9	0.17	2.4		9.3	13.6	120.25	1,087.08
P-25	Phosphate rock	2078	0.3	29.5	1.1	0.7	0.08	3.0		7.1	10.9	120.55	1,095.93
P-24	Phosphate rock	2077	1.7	28.6	1.4	0.7	0.09	2.6		7.8	10.5	122.25	1,144.55
P-23	Phosphate rock	2076	1.7	26.7	1.9	0.8	0.14	2.7		9.1	12.3	123.95	1,189.94
P-22	Phosphate rock	2075	0.8	21.1	2.0	1.0	0.10	2.1		12.2	18.5	124.75	1,206.82
P-21	Phosphate rock, argillaceous, dolomitic	2074	0.9	16.4	2.2	1.3	0.09	1.8		14.7	24.4	125.65	1,221.58

P-20	Phosphate rock, argillaceous, dolomitic	2073	1.2	12.8	2.8	1.4	0.08	1.4	17.1	28.0	126.85	1,236.94
P-19	Phosphate rock, argillaceous, dolomitic	2072	1.1	15.5	2.7	1.3	0.06	1.7	14.0	27.3	127.95	1,253.99
P-18	Dolomite, argillaceous	2071	0.7	6.9	2.0	1.2	0.06	0.82	26.5	23.8	128.65	1,258.82
P-17	Dolomite, phosphatic, argillaceous	2070	0.4	13.3	1.7	1.1	0.05	1.6	19.0	22.7	129.05	1,264.14
P-16	Dolomite	2069	2.3	5.2	1.2	0.5	0.05	0.55	32.6	16.1	131.35	1,276.10
P-15	Phosphate rock	VEM-12-47 <sup>2</sup>	1.3	21.55	3.1	1.3	0.05	2.5	11.9	18.5	132.65	1,304.11
P-14	Dolomite	VEM-11-47 <sup>2</sup>	0.5	6.4	0.5	0.8	0.05	0.74	31.7	16.5	133.15	1,307.31
P-13	Phosphate rock, dolomitic	VEM-10-47 <sup>2</sup>	0.9	15.69	1.2	1.5	0.05	1.6	20.2	16.2	134.05	1,321.43
P-12	Dolomite, phosphatic	VEM-9-47 <sup>2</sup>	0.5	11.5	0.9	0.7	0.05	1.3	27.3	12.2	134.55	1,327.18
P-11	Phosphate rock	VEM-8-47 <sup>2</sup>	0.7	28.9	1.1	0.7	0.11	3.4	9.1	7.9	135.25	1,347.41
P-10	Mudstone	VEM-7-47 <sup>2</sup>	0.4	7.5	5.6	2.7	0.09	0.91	18.3	44.0	135.65	1,350.41
P-9	Dolomite, phosphatic, argillaceous	2066	1.4	9.7	2.4	1.4	0.09	0.93	25.6	20.0	137.05	1,363.99
P-8	Phosphate rock, argillaceous	2065	0.4	20.6	3.2	1.6	0.17	2.2	9.0	26.4	137.45	1,372.23
P-7	Mudstone	2064	0.5	5.0	4.2	3.4	0.36	0.77	11.5	62.7	137.95	1,374.73
P-6	Mudstone, dolomitic	VEM-6-47	2.6	0.26	7.5	2.5	0.09	0.12	14.9	64.7	140.55	1,375.41
P-5	Mudstone	VEM-5-47	0.5	0.3	9.7	3.1	0.04	0.19	10.7	73.5	141.05	1,375.56
P-4	Mudstone	VEM-4-47	0.6	0.44	9.8	4.6	0.19	0.29	12.8	74.7	141.65	1,375.82
P-3	Mudstone	VEM-3-47	0.5	0.16	8.8	3.7	0.11	0.23	6.6	81.5	142.15	1,375.90
P-2	Mudstone	VEM-2-47	1.4	0.67	10.1	3.1	0.08	0.25	6.5	80.3	143.55	1,376.84
P-1	Phosphate rock	VEM-1-47	0.2	29.05	2.5	0.7	0.10	2.9	7.4	8.3	143.75	1,382.65

Wells formation												
Cw-5	Limestone, sandy	--	4.3	--	--	--	--	--	--	--	4.3	--
Cw-4	Limestone	--	2.8	--	--	--	--	--	--	--	7.1	--
Cw-3	Siltstone, calcareous	--	3.0	--	--	--	--	--	--	--	10.0	--
Cw-2	Limestone, sandy	--	3.8	--	--	--	--	--	--	--	13.9	--
Cw-1	Limestone	--	9.0	--	--	--	--	--	--	--	22.9	--

<sup>2</sup> See additional analyses of selected samples at end of chemical analyses tables.

Additional analyses of Coal Canyon samples

Bed no.	Sample no.	SiO <sub>2</sub>	CaO	MgO	Na <sub>2</sub> O	K <sub>2</sub> O	TiO <sub>2</sub>	H <sub>2</sub> O-	CO <sub>2</sub>	S as SO <sub>3</sub>
Td- 1	VEM-97-47	61.04	8.16	2.1	0.95	3.40	0.65	0.75	6.9	nil
U- 27	VEM-96-47	23.48	37.18	0.45	1.00	1.05	0.25	0.54	1.6	1.2
U- 26	VEM-95-47	37.30	22.60	1.4	--	--	--	0.88	2.3	0.75
U- 25	VEM-94-47	43.60	19.80	5.4	0.72	1.22	0.27	0.30	13.5	0.43
U- 24	VEM-93-47	74.62	4.70	0.84	0.97	1.20	0.34	0.30	2.9	<0.1
U- 23	VEM-92-47	78.46	3.60	0.51	0.62	1.50	0.34	0.30	0.7	0.22
U- 22	VEM-91-47	65.22	4.00	0.88	--	--	0.52	1.23	0.2	0.32
U- 21	VEM-90-47	59.54	7.32	1.1	3.10	0.69	0.49	1.89	0.5	0.39
U- 20	VEM-89-47	63.04	5.80	1.2	0.50	3.50	0.53	1.31	0.4	0.26
U- 19	VEM-88-47	65.32	8.36	2.6	2.20	0.57	0.35	0.57	5.9	0.11
U- 18	VEM-87-47	61.52	8.20	3.7	0.40	2.40	0.52	0.50	8.4	nil
U- 17	VEM-86-47	23.50	18.20	8.8	0.30	1.50	0.24	0.36	22.7	<0.1
U- 16	VEM-85-47	62.30	8.20	3.1	0.50	2.13	0.43	0.46	7.1	0.17
U- 15	VEM-84-47	62.36	10.20	3.0	0.44	1.85	0.37	0.41	8.8	0.21
U- 14	VEM-83-47	70.84	4.90	1.3	2.40	0.49	0.46	0.77	3.1	0.20
U- 13	VEM-82-47	66.84	4.20	1.9	0.60	2.77	0.44	0.64	3.1	0.20
U- 12	VEM-81-47	65.02	5.30	2.2	3.10	0.30	0.44	0.82	4.2	0.13
U- 11	VEM-80-47	61.70	5.40	2.0	0.25	3.20	0.44	0.86	3.9	0.20
U- 10	VEM-79-47	57.51	10.80	4.4	0.28	1.79	0.37	0.55	10.8	0.28
U- 9	VEM-78-47	70.14	2.00	0.86	0.40	3.10	0.55	0.92	0.3	0.31
U- 8	VEM-77-47	72.94	1.42	0.79	3.20	0.50	0.52	0.78	0.2	0.17
U- 7	VEM-76-47	71.02	4.40	0.73	0.52	2.60	0.34	0.54	2.0	0.21
U- 6	VEM-75-47	24.86	35.60	0.62	0.85	1.30	0.14	0.48	4.5	1.0
U- 5	VEM-74-47	67.60	8.40	0.55	0.40	1.83	0.33	0.38	1.8	0.24
U- 4	VEM-73-47	74.34	9.00	0.40	0.60	0.60	0.09	0.16	6.6	0.10
U- 3	VEM-72-47	69.00	13.20	0.39	0.32	0.42	0.10	0.13	5.3	0.21
U- 2	VEM-71-47	27.60	37.10	0.27	0.53	0.75	0.13	0.27	1.7	1.0
U- 1	VEM-70-47	34.00	30.40	0.59	0.57	1.70	0.20	0.68	1.6	0.95
--	VEM-69-47	61.05	19.00	1.00	--	--	--	0.09	14.7	<0.1
R- 7	VEM-68-47	73.49	11.80	0.78	--	--	--	0.12	9.6	nil
R- 6	VEM-67-47	72.48	12.00	0.64	--	--	--	0.05	9.3	<0.1
R- 5	VEM-66-47	66.49	16.40	0.41	--	--	--	0.06	12.7	nil
R- 4	VEM-65-47	73.72	11.50	0.41	0.89	2.72	--	0.15	9.5	<0.1
R- 3	VEM-64-47	66.91	14.00	0.48	--	--	--	0.08	11.2	<0.1
R- 2	VEM-63-47	87.43	14.00	0.63	--	--	--	0.14	10.9	<0.1
R- 1	VEM-62-47	63.28	18.00	0.62	--	--	--	0.07	14.1	nil
P-107	DML- 9-47	17.58	29.80	11.1	0.54	0.63	0.14	0.26	33.8	0.51
P-106	DML- 8-47	17.80	39.40	0.47	1.50	1.20	0.20	0.67	2.6	2.3

P-105	DML- 7-47	61.52	5.60	0.82	0.35	3.90	0.01	0.79	0.9	0.60
P-104	DML- 6-47	57.58	9.00	0.67	0.59	3.30	0.47	1.02	0.8	0.91
P-103	DML- 5-47	61.14	6.60	0.63	0.40	3.57	0.45	1.04	0.6	0.76
P-102	DML- 4-47	55.26	9.00	4.2	0.84	2.53	0.54	0.43	10.4	0.31
P-101	DML- 3-47	57.11	10.40	0.90	1.02	1.67	0.43	0.93	3.2	0.77
P-100	DML- 2-47	17.70	40.80	0.39	1.09	0.80	0.17	0.62	3.8	2.0
P- 99	DML- 1-47	30.02	22.20	10.0	1.00	1.22	0.31	0.31	26.6	0.48
P- 98	2063 <sup>2</sup>	9.91	46.2	0.24	0.83	0.60	0.09	0.50	4.4	2.3
P- 97	2062	4.73	49.1	0.20	1.01	0.39	0.07	0.46	2.0	2.9
P- 96	2061 <sup>2</sup>	13.87	39.8	0.37	0.76	1.10	0.16	1.47	1.7	2.9
P- 95	2060	8.85	44.1	0.34	1.03	0.67	0.07	1.26	2.3	3.2
P- 94	2059	13.28	39.7	0.36	0.91	0.92	0.12	1.73	1.9	4.0
P- 93	2058	6.49	45.7	0.24	1.16	0.54	0.05	1.02	2.2	3.5
P- 92	VEM-61-47	27.10	32.40	0.39	1.20	1.80	0.26	1.12	1.3	2.8
P- 91	VEM-60-47	47.36	12.80	3.8	0.96	2.30	0.42	0.83	8.8	1.1
P- 90	VEM-59-47	32.32	25.60	4.9	0.90	1.47	0.01	0.32	24.8	0.85
P- 89	VEM-58-47	12.90	42.24	0.33	1.00	0.77	0.14	0.89	1.6	3.2
P- 88	VEM-57-47	6.70	48.42	0.41	1.14	0.45	0.08	0.56	11.8	2.3
P- 87	VEM-56-47	27.70	31.46	0.42	1.09	1.24	0.32	0.87	1.8	2.5
P- 86	VEM-55-47	15.50	41.60	0.31	1.25	0.70	0.16	0.89	2.1	2.9
P- 85	VEM-54-47	14.10	44.18	0.29	1.20	0.40	0.16	0.58	4.7	2.3
P- 84	VEM-53-47	34.24	25.41	0.43	1.09	1.60	0.40	1.08	2.0	2.4
P- 83	VEM-52-47	13.20	44.00	0.26	0.94	0.62	0.15	0.47	2.3	1.6
P- 82	VEM-51-47	35.27	26.80	2.1	0.74	1.45	0.19	0.34	20.8	0.90
P- 81	VEM-50-47	47.21	13.40	4.2	0.84	2.43	0.42	0.62	10.0	0.90
P- 80	VEM-49-47	31.21	26.4	0.90	0.45	1.89	0.32	1.35	9.6	2.1
P- 79	VEM-48-47	47.41	15.40	2.21	0.62	2.45	0.10	0.86	10.5	1.0
P- 78	VEM-47-47 <sup>2</sup>	7.70	42.10	0.43	0.90	0.67	0.14	1.55	1.9	3.5
P- 77	VEM-46-47	21.10	30.80	1.70	1.00	1.49	0.26	1.37	14.0	2.2
P- 76	VEM-45-47	4.82	50.22	1.8	0.60	0.72	0.03	0.13	40.2	0.44
P- 75	VEM-44-47	47.18	8.40	1.9	1.25	2.12	0.52	0.51	5.0	8.6
P- 74	VEM-43-47	41.64	6.05	2.3	0.78	2.55	0.18	0.83	5.9	12.5
P- 73	VEM-42-47	45.64	4.20	2.7	0.99	2.78	0.23	0.52	5.1	10.6
P- 72	VEM-41-47	52.58	4.20	2.9	1.30	2.85	0.36	0.32	5.6	8.4
P- 71	VEM-40-47	37.36	15.60	1.4	1.27	2.11	0.28	0.37	6.4	9.4
P- 70	VEM-39-47	22.98	36.40	1.8	1.10	0.70	0.06	0.29	29.3	0.60
P- 69	VEM-38-47	48.07	13.20	0.53	1.30	2.38	0.48	1.33	0.52	1.6
P- 68	VEM-37-47	59.80	5.40	2.4	1.50	2.30	0.42	0.99	5.1	0.90
P- 67	VEM-36-47	53.23	9.48	0.48	1.20	2.62	0.61	1.41	0.59	1.6
P- 66	VEM-35-47	33.46	23.20	5.4	1.20	1.30	0.24	0.46	23.0	0.62
P- 65	VEM-34-47	35.28	22.2	1.2	1.20	2.14	0.38	1.32	6.1	2.0
P- 64	VEM-33-47	32.75	20.20	8.6	1.44	1.5	0.27	0.39	23.3	0.55
P- 63	VEM-32-47	29.90	24.40	0.80	1.02	1.95	0.38	1.62	5.1	2.2

<sup>2</sup> See additional analyses of selected samples at end of chemical analyses tables.

Bed no.	Sample no.	SiO <sub>2</sub>	CaO	MgO	Na <sub>2</sub> O	K <sub>2</sub> O	TiO <sub>2</sub>	H <sub>2</sub> O-	CO <sub>2</sub>	S as SO <sub>3</sub>
P- 62	VEM-31-47	20.82	28.40	1.0	0.94	1.35	0.26	1.85	7.3	3.0
P- 61	VEM-30-47	19.60	32.40	5.3	0.95	0.95	0.13	0.45	30.1	0.56
P- 60	VEM-29-47	18.63	25.8	12.3	1.26	0.97	0.10	0.54	30.3	0.80
P- 59	VEM-28-47	22.60	26.40	3.4	0.89	1.70	0.29	1.76	7.9	2.5
P- 58	VEM-27-47	8.27	29.60	15.1	0.80	0.50	0.06	0.77	36.2	1.0
P- 57	VEM-26-47	32.60	20.07	0.63	0.75	2.60	0.38	1.86	0.86	2.5
P- 56	VEM-25-47	7.82	29.72	15.0	0.60	0.71	0.10	0.43	36.7	0.60
P- 55	VEM-24-47	13.10	32.05	6.1	0.79	1.22	0.18	1.23	14.4	2.5
P- 54	VEM-23-47	8.69	31.80	10.9	0.50	0.66	0.11	0.58	32.3	1.1
P- 53	VEM-22-47 <sup>3</sup>	10.60	32.82	1.0	0.75	1.20	0.13	1.00	2.4	3.9
P- 52	VEM-21-47	5.20	36.00	13.0	0.60	0.40	0.13	0.41	33.00	1.0
P- 51	VEM-20-47	15.53	36.45	0.77	1.15	1.12	0.25	1.24	2.2	3.1
P- 50	VEM-19-47	14.50	27.20	8.0	0.78	1.12	0.04	1.07	28.6	1.7
P- 49	VEM-18-47	11.50	40.37	0.98	1.56	0.95	0.16	0.53	3.4	3.0
P- 48	VEM-17-47	11.19	26.60	13.2	0.58	0.82	0.07	1.00	31.2	1.7
P- 47	VEM-16-47	10.47	27.36	13.9	0.84	0.69	0.06	1.10	32.8	1.6
P- 46	VEM-15-47	19.38	24.96	9.9	0.89	1.59	0.22	1.15	24.4	1.6
P- 45	VEM-14-47	5.17	45.45	0.39	1.00	0.49	0.07	1.01	4.3	2.7
P- 44	LES- 10-47	12.80	38.80	0.58	1.35	0.79	0.15	1.46	2.0	3.8
P- 43	LES- 9-47	9.50	43.73	0.57	0.97	0.54	0.11	0.79	2.8	3.0
P- 42	LES- 8-47	14.42	28.40	12.8	0.70	0.85	0.11	0.44	30.6	0.96
P- 41	LES- 7-47	36.80	18.40	1.9	1.44	2.62	0.28	1.06	4.3	1.8
P- 40	LES- 6-47	38.32	16.2	8.4	1.19	2.17	0.06	0.59	19.5	0.63
P- 39	LES- 5-47	36.80	20.00	1.5	0.87	3.27	0.34	0.20	3.5	1.8
P- 38	LES- 4-47	25.56	23.2	12.4	0.45	0.85	0.06	0.41	28.6	0.71
P- 37	LES- 3-47	26.12	24.20	10.3	0.80	1.05	0.26	0.54	24.4	1.0
P- 36	LES- 2-47	25.76	24.53	9.1	1.00	0.97	0.13	0.60	22.6	1.2
P- 35	LES- 1-47	23.70	34.40	0.41	1.00	1.40	0.22	0.77	1.6	2.9
P- 34	VEM-13-47	10.75	43.65	0.19	1.08	0.51	0.08	0.72	1.6	3.4
P- 33	2086	44.45	12.7	0.64	0.30	2.73	0.40	3.88	1.1	4.5
P- 32	2085	--	--	5.4	--	--	--	--	13.1	2.0
P- 31	2084	30.01	27.2	0.39	0.86	1.81	0.33	2.10	1.3	3.7
P- 30	2083	--	--	3.0	--	--	--	--	7.2	2.1
P- 29	2082	36.23	21.5	4.8	1.10	2.03	0.36	1.19	11.6	3.1
P- 28	2081	22.93	26.7	9.5	1.02	1.30	0.23	0.75	22.9	1.3
P- 27	2080 <sup>2</sup>	15.75	37.5	0.46	0.95	1.35	0.16	1.52	2.0	3.5
P- 26	2079 <sup>2</sup>	14.06	39.7	1.5	0.77	1.36	0.13	1.09	4.9	2.8
P- 25	2078	12.04	42.9	0.59	0.72	0.99	0.10	0.99	2.5	2.4
P- 24	2077	11.63	42.3	0.60	0.90	0.88	0.10	0.87	3.3	2.8
P- 23	2076	13.36	41.2	0.80	0.95	1.07	0.12	1.22	3.6	3.1
P- 22	2075	18.16	35.4	2.2	0.83	1.51	0.16	1.48	6.4	3.1
P- 21	2074	22.77	30.4	3.7	0.70	1.88	0.21	1.39	9.8	2.7

P- 20	2073	25.87	27.8	5.0	0.60	1.53	0.21	1.30	12.5	2.1
P- 19	2072	25.91	29.4	3.3	0.63	2.26	0.21	1.38	8.6	2.3
P- 18	2071	21.20	26.7	9.0	0.30	2.29	0.11	0.70	23.5	1.1
P- 17	2070	21.25	30.9	5.9	0.42	1.65	0.31	0.71	16.0	1.5
P- 16	2069	16.21	28.2	12.2	0.33	0.79	0.09	0.59	33.2	1.0
P- 15	VEM-12-47 <sup>2</sup>	16.64	36.40	2.4	0.83	1.52	0.15	0.71	7.1	2.6
P- 14	VEM-11-47 <sup>2</sup>	15.20	30.60	12.3	0.40	0.78	0.08	0.57	29.8	1.1
P- 13	VEM 10-47 <sup>2</sup>	16.02	35.00	6.7	0.77	0.83	0.17	0.55	17.7	1.2
P- 12	VEM- 9-47 <sup>2</sup>	13.00	32.15	10.1	0.62	0.69	0.12	1.46	25.3	2.3
P- 11	VEM- 8-47 <sup>2</sup>	10.09	43.82	0.6	1.09	0.45	0.16	0.70	3.7	3.5
P- 10	VEM- 7-47 <sup>2</sup>	39.08	16.32	3.7	0.45	2.25	0.24	1.53	8.0	2.8
P- 9	2066	17.98	26.8	9.5	0.42	1.31	0.14	1.35	21.9	2.1
P- 8	2065	26.27	31.1	0.57	0.79	1.58	0.19	1.82	1.9	3.7
P- 7	2064	55.29	9.1	0.80	0.59	3.96	0.45	2.36	0.8	3.1
P- 6	VEM- 6-47	53.36	10.00	5.8	0.40	4.10	0.18	0.33	13.3	0.39
P- 5	VEM- 5-47	61.56	4.96	3.0	0.17	4.63	0.16	0.78	6.1	1.5
P- 4	VEM- 4-47	61.56	0.64	0.87	0.24	5.03	0.11	1.58	0.3	3.7
P- 3	VEM- 3-47	71.04	7.28	0.72	0.30	5.07	0.10	0.95	0.3	1.6
P- 2	VEM- 2-47	69.28	2.60	1.4	0.35	4.50	0.18	0.75	2.3	1.1
P- 1	VEM- 1-47	10.20	42.24	1.9	0.95	0.40	0.07	0.42	5.1	2.2

<sup>2</sup> See additional analyses of selected samples on next page.

<sup>3</sup> The SiO<sub>2</sub> analysis for this sample is probably in error.



Additional analyses of selected samples<sup>4</sup>

Bed no.	Sample no.	P <sub>2</sub> O <sub>5</sub>	V <sub>2</sub> O <sub>5</sub>	F	SiO <sub>2</sub>	TiO <sub>2</sub>	CaO	MgO	Na <sub>2</sub> O	K <sub>2</sub> O	MnO	Ni
P-98	2063	--	--	--	--	--	--	--	--	--	--	--
P-96	2061	28.77	0.31	3.03	10.06	0.06	41.73	0.20	0.73	0.96	0.003	0.002
P-78	VEM-47-47	29.89	0.05	3.13	2.43	0.04	42.10	2.36	0.80	0.55	0.009	0.023
P-27	2080	26.33	0.28	2.61	12.63	0.08	38.96	0.22	0.91	1.16	0.005	0.002
P-26	2079	--	--	--	--	--	--	--	--	--	--	--
P-12 to 15	2068 <sup>5</sup>	--	--	--	--	--	--	--	--	--	--	--
P-10 to 11	2067 <sup>6</sup>	18.48	0.10	2.01	16.13	0.08	31.48	4.21	0.65	1.16	0.035	0.039

	Cr <sub>2</sub> O <sub>3</sub>	Co	Zn	Cu	Pb	Ag	MoO <sub>3</sub>	W	Cl	Organic matter
	--	--	--	--	--	0.0001	--	--	--	-- <sup>7</sup>
	0.14	0.004	0.008	0.003	0.001	0.0001	0.002	--	0.004	5.28 <sup>7</sup>
	0.28	0.006	0.001	0.013	0.005	0.0002	0.002	<0.005	--	7.18 <sup>7</sup>
	0.08	0.004	0.010	0.0006	0.001	0.0002	0.012	--	0.004	5.82 <sup>7</sup>
	--	--	--	--	--	0.0003	--	--	--	--
	--	--	--	--	--	0.0003	--	--	--	-- <sup>8</sup>
	0.12	0.004	0.002	0.020	0.005	0.0004	0.002	<0.005	--	4.64 <sup>8</sup>

<sup>4</sup> Analyses made by U. S. Geological Survey, Geochemistry and Petrology Branch.

<sup>5</sup> Sample no. 2068 is a composite of samples VEM-9-47 through VEM-12-47.

<sup>6</sup> Sample no. 2067 is a composite of samples VEM-7-47 and VEM-8-47.

<sup>7</sup> CO<sub>2</sub> and S reported present.

<sup>8</sup> CO<sub>2</sub> reported present, strong, and S reported present.

SPECTROGRAPHIC ANALYSES—COAL CANYON, WYOMING. LOT NO. 1201.

Semi-quantitative analyses of samples of the phosphatic shale member of Phosphoria formation, Coal Canyon, Wyoming (see immediately preceding pages for location of section, thickness and description of strata, and chemical analyses of samples), made by U. S. Bureau of Mines Laboratory, Albany, Oregon. In addition to the elements listed in the table below, Sb, As, Bi, Cd, Co, Ga, Au, Li, Hg, Pt, Ta, Sn, and W were looked for in all samples but were not detected.

Explanation of symbols

A = more than 10 percent    E = 0.01-0.1 percent  
B = 5-10 percent    F = 0.001-0.01 percent  
C = 1-5 percent    G = less than 0.001 percent  
D = 0.1-1 percent    ND = not detected

Bed no.	Sample no.	Al	Ba	Be	B	Ca	Cr	Cb	Cu	Fe	Pb	Mg	Mn	Mo	Ni	Si	Ag	Na	Sr	Ti	V	Zn	Zr
P-107	DML- 9-47	C	ND	ND	F F	A	F	ND	G	D	E	C	E	F	F	B	ND	E	ND	E	F	ND	F
P-106	DML- 8-47	C	ND	ND	F F	A	E	ND	G	D	ND	D	F	F	E	B	ND	D	ND	E	E	ND	E
P-105	DML- 7-47	C	ND	ND	F F	C	E	ND	G	D	ND	D	F	F	E	A	ND	E	ND	D	E	ND	E
P-104	DML- 6-47	C	ND	ND	F F	C	E	ND	G	D	ND	D	F	F	E	A	ND	D	ND	E	E	ND	E
P-103	DML- 5-47	C	ND	ND	F F	C	E	ND	G	D	ND	D	F	F	E	A	ND	E	ND	E	E	ND	E
P-102	DML- 4-47	C	ND	ND	F F	C	F	ND	G	D	ND	D	E	F	E	A	ND	D	ND	E	F	ND	E
P-101	DML- 3-47	C	ND	ND	F F	C	E	ND	G	D	ND	D	E	F	E	A	ND	D	ND	E	E	ND	E
P-100	DML- 2-47	C	ND	ND	F F	A	E	ND	G	D	ND	D	F	F	E	B	ND	D	ND	E	F	ND	E
P-99	DML- 1-47	C	ND	ND	F F	B	F	ND	G	D	ND	C	E	F	F	A	ND	E	ND	E	F	ND	E
P-98	2063	C	ND	ND	F F	A	E	ND	G	D	ND	D	F	F	E	C	E	D	ND	E	E	ND	E
P-97	2062	D	E	G	E E	A	D	ND	F	D	E	D	E	F	E	B	G	D	E	E	E	F	E
P-96	2061	D	E	G	E E	A	D	ND	F	C	E	D	E	F	E	A	G	D	E	E	D	E	E
P-95	2060	C	ND	ND	F F	A	E	E	G	D	ND	D	F	F	E	C	G	D	ND	E	D	E	E
P-94	2059	C	ND	ND	F F	A	E	E	G	D	ND	D	ND	F	E	C	G	D	ND	E	D	E	E
P-93	2058	C	ND	ND	F F	A	E	ND	G	E	ND	D	ND	F	E	C	G	D	ND	E	D	E	E
P-92	VEM-61-47	C	E	G	E F	A	D	ND	F	C	E	D	E	E	E	A	G	D	E	E	E	E	E
P-91	VEM-60-47	C	E	ND	F F	C	E	E	G	D	ND	C	E	F	E	A	G	D	ND	E	E	E	E
P-90	VEM-59-47	D	ND	ND	F F	C	E	ND	G	D	ND	C	E	ND	F	B	ND	D	ND	E	E	ND	F
P-89	VEM-58-47	D	ND	ND	F F	B	E	ND	G	D	ND	D	F	F	E	C	G	D	E	E	D	ND	F
P-88	VEM-57-47	D	ND	ND	F F	C	E	ND	G	D	ND	D	F	F	ND	C	ND	E	E	E	E	ND	F
P-87	VEM-56-47	C	E	ND	F F	A	E	E	G	C	ND	D	F	F	E	B	G	D	D	E	D	E	E
P-86	VEM-55-47	D	E	ND	F F	A	E	ND	G	D	ND	D	F	ND	F	C	G	D	E	E	E	ND	E
P-85	VEM-54-47	D	ND	ND	F F	A	E	ND	G	D	ND	D	F	ND	F	C	G	D	E	E	E	ND	E
P-84	VEM-53-47	C	E	ND	F F	B	E	E	G	D	ND	D	F	F	E	A	G	D	E	E	E	ND	E
P-83	VEM-52-47	D	ND	ND	F F	A	E	ND	G	D	ND	E	F	F	F	C	G	D	D	E	E	ND	E
P-82	VEM-51-47	C	E	ND	F F	A	E	E	G	D	ND	D	E	F	F	A	ND	E	ND	E	E	ND	E
P-81	VEM-50-47	C	E	ND	F F	B	E	E	G	D	ND	C	E	F	E	A	G	D	ND	E	E	ND	E
P-80	VEM-49-47	C	E	ND	F F	A	E	E	G	D	ND	D	E	F	E	A	ND	E	E	E	D	E	E
P-79	VEM-48-47	C	E	ND	F F	B	E	E	G	D	ND	D	E	F	E	A	ND	E	ND	E	E	ND	E
P-78	VEM-47-47	D	E	ND	F F	A	E	E	G	D	ND	D	F	F	E	C	G	D	E	E	E	ND	F

Bed no.	Sample no.	Al	Ba	Be	B	Ca	Cr	Cb	Cu	Fe	Pb	Mg	Mn	Mo	Ni	Si	Ag	Na	Sr	Ti	V	Zn	Zr
P- 77	VEM-46-47	C	E	ND	E	A	E	E	G	D	ND	D	E	ND	E	B	G	D	E	E	E	ND	F
P- 76	VEM-45-47	D	ND	ND	F	A	E	E	G	E	ND	D	E	ND	ND	C	ND	ND	ND	E	E	ND	F
P- 75	VEM-44-47	C	E	G	E	B	E	ND	F	C	E	C	E	E	E	A	G	D	F	D	D	E	E
P- 74	VEM-43-47	C	E	G	D	C	E	ND	F	C	E	C	E	D	D	A	G	D	F	D	D	D	E
P- 73	VEM-42-47	C	E	G	D	C	D	ND	F	B	E	C	E	D	D	A	G	D	F	D	D	D	E
P- 72	VEM-41-47	C	E	ND	E	C	E	E	G	C	ND	D	E	E	E	A	G	D	ND	D	D	E	E
P- 71	VEM-40-47	C	E	G	E	A	D	ND	F	C	E	D	E	E	E	A	G	D	F	D	D	E	E
P- 70	VEM-39-47	C	E	ND	F	A	E	E	G	D	ND	D	E	ND	F	B	ND	ND	ND	E	E	ND	E
P- 69	VEM-38-47	C	E	G	E	A	D	ND	F	C	E	D	E	F	E	A	G	D	E	D	E	F	E
P- 68	VEM-37-47	C	E	ND	E	C	E	E	G	D	ND	D	E	ND	E	A	ND	ND	ND	E	E	ND	E
P- 67	VEM-36-47	C	E	ND	E	C	E	E	G	C	ND	D	E	F	E	A	ND	ND	ND	D	E	ND	E
P- 66	VEM-35-47	C	E	ND	F	A	E	E	G	D	ND	D	E	ND	F	A	ND	ND	ND	D	E	ND	E
P- 65	VEM-34-47	C	E	ND	E	B	D	D	G	C	ND	D	E	F	E	A	G	D	ND	E	E	ND	E
P- 64	VEM-33-47	C	E	ND	F	B	E	ND	G	D	ND	C	E	ND	F	A	ND	ND	ND	E	E	ND	E
P- 63	VEM-32-47	C	E	ND	E	A	D	E	G	C	ND	D	E	F	E	A	G	D	E	E	E	E	E
P- 62	VEM-31-47	C	E	G	E	A	D	ND	F	C	E	C	E	E	E	A	G	D	E	E	D	E	E
P- 61	VEM-30-47	C	E	ND	F	A	E	D	G	D	ND	C	E	F	F	B	ND	ND	ND	E	E	ND	E
P- 60	VEM-29-47	C	E	ND	F	A	E	ND	G	D	ND	C	E	F	E	B	G	D	ND	E	E	ND	E
P- 59	VEM-28-47	C	E	G	E	A	E	ND	F	C	E	B	E	E	D	A	G	D	E	D	E	ND	E
P- 58	VEM-27-47	C	E	ND	F	B	E	ND	G	E	ND	C	E	F	E	C	ND	ND	ND	E	E	ND	E
P- 57	VEM-26-47	C	E	ND	E	B	E	ND	G	D	ND	D	F	F	E	B	G	ND	E	E	E	E	E
P- 56	VEM-25-47	C	E	ND	F	A	E	ND	G	E	ND	C	F	ND	F	C	ND	E	E	E	E	ND	E
P- 55	VEM-24-47	C	E	ND	F	A	E	ND	G	D	ND	C	F	F	E	C	G	E	E	E	E	E	E
P- 54	VEM-23-47	C	E	ND	F	A	E	ND	G	E	ND	C	F	ND	F	C	G	E	E	E	E	ND	E
P- 53	VEM-22-47	C	E	ND	F	A	E	E	G	D	ND	D	F	F	E	C	ND	E	E	E	E	E	E
P- 52	VEM-21-47	D	E	ND	F	A	E	ND	G	E	ND	C	F	ND	F	C	G	E	E	E	E	ND	E
P- 51	VEM-20-47	C	E	ND	F	A	E	E	G	D	ND	C	F	F	E	C	G	E	E	E	E	ND	E
P- 50	VEM-19-47	C	E	ND	F	A	E	ND	G	D	ND	C	F	F	E	C	G	E	E	E	E	ND	E
P- 49	VEM-18-47	C	E	G	E	A	D	ND	F	C	E	C	E	F	E	B	G	E	E	E	E	F	E
P- 48	VEM-17-47	C	E	ND	F	A	E	ND	G	E	ND	C	F	F	E	C	G	E	E	E	E	ND	E
P- 47	VEM-16-47	D	E	ND	F	A	E	ND	G	E	ND	C	F	F	E	C	G	E	E	E	E	ND	E
P- 46	VEM-15-47	C	E	G	E	B	E	ND	F	C	E	C	E	F	E	A	G	E	E	E	E	ND	E
P- 45	VEM-14-47	D	E	ND	F	A	E	ND	G	E	ND	C	F	F	E	C	G	E	E	E	E	ND	E
P- 44	LES-10-47	C	ND	ND	F	A	E	E	G	D	ND	D	ND	F	E	C	G	E	E	E	D	E	E
P- 43	LES- 9-47	C	ND	ND	F	A	E	ND	G	E	ND	D	ND	F	E	C	G	E	ND	E	E	E	E
P- 42	LES- 8-47	C	ND	ND	F	A	E	ND	G	E	ND	C	F	F	E	A	G	E	ND	E	E	E	E
P- 41	LES- 7-47	C	ND	ND	F	B	E	ND	G	D	ND	C	F	F	E	A	G	E	ND	E	E	E	E
P- 40	LES- 6-47	C	ND	ND	F	B	E	ND	G	D	ND	C	F	F	E	A	G	E	ND	E	E	ND	E
P- 39	LES- 5-47	C	ND	ND	F	B	E	ND	G	D	ND	C	F	F	E	A	G	E	ND	E	E	E	E
P- 38	LES- 4-47	C	ND	ND	F	A	E	ND	G	E	ND	C	F	F	E	A	G	E	ND	E	E	ND	E
P- 37	LES- 3-47	C	ND	ND	F	A	E	ND	G	E	ND	C	F	F	E	A	G	E	ND	E	E	ND	E
P- 36	LES- 2-47	C	ND	ND	F	A	E	ND	G	E	ND	C	F	F	E	A	G	E	ND	E	E	ND	E



NORTH FORK OF PINE CREEK, WYOMING. LOT NO. 1204.

Phosphatic shale member of Phosphoria formation sampled in bulldozer trench on North Fork of Pine Creek, sec. 13, T. 25 N., R. 118 W., Lincoln County, Wyoming, 10 miles northeast of Cokeville on east limb of syncline. Beds strike N. 10-25° E. and dip 37-45° W. Section measured by R. A. Hoppin, V. E. McKelvey, and L. E. Smith and sampled by R. P. Sheldon, O. A. Payne, and R. S. Sears in June and July 1947. Samples analyzed for  $P_2O_5$  and acid insoluble by U. S. Bureau of Mines Laboratory, Albany, Oregon, and for other constituents by Trace Elements Section Laboratory, U. S. Geological Survey, Washington, D. C.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble			
Phosphatic shale member of Phosphoria formation											
P-83	Mudstone, calcareous	RAH-63-47	2.2	0.3	--	--	--	67.8	2.2	0.66	
P-82	Mudstone, calcareous	RAH-62-47	2.4	7.4	--	--	--	50.7	4.6	18.42	
P-81	Limestone, argillaceous; fos. col. no. 47-HW-54 <sup>1</sup>	RAH-61-47	2.5	6.3	--	--	--	27.3	7.1	34.17	
P-80	Limestone, argillaceous; fos. col. no. 47-HW-53	RAH-60-47	1.5	0.6	--	--	--	44.0	8.6	35.07	
P-79	Limestone, argillaceous; fos. col. no. 47-HW-52	RAH-59-47	1.9	0.7	--	--	--	41.9	10.5	36.40	
P-78	Mudstone, calcareous; fos. col. no. 47-HW-51	RAH-58-47	2.7	1.2	--	--	--	60.9	13.2	39.64	
P-77	Mudstone, calcareous; fos. col. no. 47-HW-50	RAH-57-47	1.6	0.7	--	--	--	59.0	14.8	40.76	
P-76	Mudstone, calcareous	RAH-56-47	1.0	0.7	--	--	--	60.0	15.8	41.46	
P-75	Limestone, argillaceous	RAH-55-47	3.2	0.6	--	--	--	49.7	19.0	43.38	
P-74	Mudstone	RAH-54-47	3.8	1.0	--	--	--	82.7	22.8	47.18	
P-73	Mudstone, phosphatic; fos. col. no. 47-HW-21	RAH-53-47	0.9	13.3	--	--	--	61.1	23.7	59.15	
P-72	Mudstone; fos. col. no. 47-HW-20	RAH-52-47	4.4	4.7	--	--	--	83.6	28.1	79.83	
P-71	Mudstone	RAH-51-47	2.6	4.3	--	--	--	74.6	30.7	91.01	
P-70	Mudstone, calcareous	RAH-50-47	1.4	2.3	--	--	--	65.7	32.1	94.23	
P-69	Mudstone	RAH-49-47	1.3	3.3	--	--	--	79.6	33.4	98.52	
P-68	Phosphate rock	RAH-48-47	3.5	34.7	1.2	0.45	3.40	5.3	36.9	219.97	
P-67	Mudstone, calcareous	RAH-47-47	1.4	2.8	9.72	1.7	6.44	72.2	38.3	223.89	
P-66	Phosphate rock, argillaceous	RAH-46-47	4.4	25.9	3.5	0.89	3.92	23.4	42.7	337.85	
P-65	Phosphate rock; fos. col. no. 47-HW-19	RAH-45-47	1.0	30.1	2.9	1.3	2.78	17.7	43.7	367.95	
P-64	Mudstone	RAH-44-47	1.3	1.4	--	--	--	84.8	45.0	369.77	
P-63	Mudstone	LES-116-47	1.8	3.3	--	--	--	77.0	46.8	375.71	
P-62	Mudstone	LES-115-47	0.9	1.0	--	--	--	84.3	47.7	376.61	
P-61	Phosphate rock, argillaceous	LES-114-47	0.4	24.1	--	--	--	24.9	48.1	386.25	
P-60	Mudstone, phosphatic	LES-113-47	0.6	13.6	--	--	--	47.2	48.7	394.41	
P-59	Mudstone	LES-112-47	1.0	1.1	--	--	--	78.6	49.7	395.51	
P-58	Phosphate rock, calcareous, argillaceous	LES-111-47	0.4	20.8	--	--	--	22.7	50.1	403.83	
P-57	Mudstone, phosphatic	LES-110-47	0.55	14.4	--	--	--	39.4	50.65	411.74	
P-56	Limestone, argillaceous, phosphatic	LES-109-47	0.5	9.2	--	--	--	35.0	51.15	416.34	

P-55	Limestone, argillaceous; fos. col. no. 47-HW-18	LES-108-47	1.4	3.8	--	--	--	22.6	52.55	421.66
P-54	Mudstone	LES-107-47	0.5	0.5	--	--	--	67.3	53.05	421.91
P-53	Mudstone	LES-106-47	0.45	0.2	--	--	--	71.6	53.50	422.00
P-52	Mudstone	LES-105-47	0.95	0.2	--	--	--	80.1	54.45	422.19
--	Mudstone	LES-354-47	(0.5)	0.3	--	--	--	78.0	--	--
LES-354-47 represents the upper half of LES-105, bed P-52.										
P-51	Mudstone	LES-104-47	1.0	6.3	--	--	--	55.9	55.45	428.49
P-50	Mudstone, calcareous; fos. col. no. 47-HW-17	LES-103-47	0.7	2.1	--	--	--	51.7	56.15	429.96
P-49	Mudstone	LES-102-47	0.7	1.3	--	--	--	84.6	56.85	430.87
P-48	Mudstone, phosphatic	LES-101-47	0.7	12.5	--	--	--	51.1	57.55	439.62
P-47	Mudstone, calcareous and limestone	LES-100-47	3.0	0.4	--	--	--	46.7	60.55	440.82
P-46	Mudstone, calcareous	LES-99-47	2.0	0.9	--	--	--	63.0	62.55	442.62
P-45	Mudstone, phosphatic	LES-98-47	2.0	10.0	--	--	--	49.8	64.55	462.62
P-44	Mudstone, calcareous	LES-97-47	3.6	6.7	--	--	--	56.0	68.15	486.74
P-43	Phosphate rock, argillaceous, contains calcareous concretions; fos. col. no. 47-HW-41	LES-96-47	3.9	15.2	--	--	--	30.1	72.05	546.02
P-42	Limestone, argillaceous; fos. col. no. 47-HW-16	LES-95-47	2.8	1.0	--	--	--	28.3	74.85	548.82
P-41	Phosphate rock, argillaceous, calcareous	LES-94-47	1.9	16.4	--	--	--	35.9	76.75	579.98
P-40	Limestone, argillaceous, phosphatic	LES-93-47	1.0	8.4	--	--	--	34.7	77.75	588.38
P-39	Phosphate rock, argillaceous, calcareous	LES-92-47	2.1	17.6	--	--	--	33.8	79.85	625.34
P-38	Phosphate rock, argillaceous, calcareous	LES-91-47	0.5	16.3	--	--	--	35.7	80.35	633.49
P-37	Phosphate rock, argillaceous, calcareous, contains chert lenses	LES-90-47	0.75	19.0	--	--	--	26.7	81.10	647.74
P-36	Limestone, argillaceous	LES-89-47	3.0	4.7	--	--	--	22.2	84.10	661.84
P-35	Chert, contains quartz vugs; fos. col. no. 47-HW-15	LES-88-47	0.7	5.5	--	--	--	77.8	84.80	665.69
P-34	Mudstone, phosphatic	LES-87-47	0.8	13.7	--	--	--	51.4	85.60	676.65
P-33	Phosphate rock, silty and mudstone	LES-86-47	0.5	26.1	--	--	--	20.4	86.10	689.70
P-32	Phosphate rock	LES-85-47	2.15	33.0	--	--	--	8.6	88.25	760.65
P-31	Phosphate rock, argillaceous	LES-84-47	0.5	18.0	--	--	--	39.1	88.75	769.65
P-30	Mudstone, phosphatic, calcareous	LES-83-47	2.3	13.1	--	--	--	41.8	91.05	799.78
P-29	Limestone, argillaceous	LES-82-47	2.2	0.6	--	--	--	35.1	93.25	801.10
P-28	Mudstone, calcareous, phosphatic	LES-81-47	0.8	7.8	--	--	--	51.0	94.05	807.35
P-27	Limestone, argillaceous, contains chert lenses	LES-80-47	0.8	5.7	--	--	--	30.0	94.85	811.90
P-26	Phosphate rock	LES-79-47	0.85	30.2	--	--	--	12.9	95.70	837.57
P-25	Mudstone, calcareous	LES-78-47	0.3	4.8	--	--	--	62.1	96.00	839.01
P-24	Mudstone, calcareous	LES-77-47	1.2	0.4	--	--	--	70.5	97.20	839.49
P-23	Mudstone	LES-76-47	0.35	3.8	--	--	--	71.2	97.55	840.82
P-22	Mudstone	LES-75-47	1.6	5.4	--	--	--	73.7	99.15	849.46

Fossil collection made by H. Wedow, Paleontology and Stratigraphy Branch, U. S. Geological Survey.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent $P_2O_5$ (cumulative)
				$P_2O_5$	$Al_2O_3$	$Fe_2O_3$	Loss on ignition	Acid insoluble		
P-21	Mudstone	LES-74-47	0.75	1.7	--	--	--	83.9	99.90	850.74
P-20	Phosphate rock	LES-73-47	0.9	31.7	--	--	--	15.6	100.80	879.26
P-19	Mudstone, contains chert lenses	LES-72-47	4.0	1.0	--	--	--	92.7	104.80	883.26
P-18	Mudstone and chert	LES-71-47	1.8	1.0	--	--	--	85.8	106.60	885.06
P-17	Mudstone, calcareous and chert	LES-58-47	2.0	0.6	--	--	--	43.9	108.60	886.26
P-16	Mudstone, calcareous and chert	LES-57-47	1.9	1.1	--	--	--	60.6	110.50	888.36
P-15	Mudstone, calcareous and chert	LES-56-47	1.5	1.1	--	--	--	66.6	112.00	890.00
P-14	Mudstone, calcareous and chert	LES-55-47	1.2	1.2	--	--	--	48.7	113.20	891.44
P-13	Limestone, argillaceous and phosphate rock	LES-54-47	0.7	6.3	--	--	--	26.0	113.90	895.86
P-12	Limestone, argillaceous	LES-53-47	0.85	1.9	--	--	--	25.4	114.75	897.47
P-11	Mudstone, calcareous	LES-52-47	1.8	6.8	--	--	--	52.7	116.55	909.71
P-10	Limestone, argillaceous	LES-51-47	0.65	2.2	--	--	--	19.0	117.20	911.14
P-9	Mudstone, phosphatic	LES-50-47	0.85	13.2	--	--	--	46.3	118.05	922.36
P-8	Mudstone, calcareous	LES-49-47	0.45	3.9	--	--	--	57.4	118.50	924.12
P-7	Limestone, argillaceous	LES-48-47	1.9	0.6	--	--	--	34.9	120.40	925.26
P-6	Mudstone, calcareous	LES-47-47	0.5	1.3	--	--	--	74.0	120.90	925.90
P-5	Limestone, argillaceous	VEM-104-47	1.9	0.4	--	--	--	33.0	122.80	926.66
P-4	Mudstone	VEM-103-47	0.5	1.1	--	--	--	75.6	123.30	927.22
P-3	Mudstone, calcareous	VEM-102-47	1.9	0.4	--	--	--	57.9	125.20	927.98
P-2	Limestone, argillaceous	VEM-101-47	1.1	0.4	--	--	--	45.4	126.30	928.42
P-1	Phosphate rock, mudstone, and chert	VEM-100-47	0.4	26.4	--	--	--	17.4	126.70	938.98

Wells formation

Cw-2	Sandstone, phosphatic	VEM-99-47	1.4	12.0	--	--	--	56.1	1.4	--
Cw-1	Mudstone, calcareous	VEM-98-47	1.9	1.0	--	--	--	53.6	3.3	--

SPECTROGRAPHIC ANALYSES--NORTH FORK OF PINE CREEK, WYOMING. LOT NO. 1204.

Semi-quantitative analyses of a few samples of the Phosphoria formation, North Fork of Pine Creek, Wyoming (see immediately preceding pages for location of section, thickness and description of strata, and chemical analyses of samples), made by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch. In addition to the elements listed in the table below, Sb, As, Be, Bi, Cd, Ce, Cs, Co, Cb, Ge, In, Hg, Mo, Nd, Pt, Re, Rb, Sc, Ta, Tl, Th, and W were looked for in all samples but were not detected.

Explanation of symbols

A = more than 10 percent      F = 0.001-0.01 percent  
 B' = 1-10 percent<sup>1</sup>      G = less than 0.001 percent  
 D = 0.01-0.1 percent      ND = not detected  
 E = 0.01-0.1 percent

Bed no.	Sample no.	Al	Ba	B	Ca	Cr	Cu	Fe	La	Pb	Mg	Mn	Ni	P'	Si	Ag	Na	Sr	Sn	Ti	V	Y	Zn	Zr
P-68	RAH-48-47	D	F	F	A	D	F	D	E	E	D	F	F	--	B'	G	D	D	F	E	E	E	F	E
P-67	RAH-47-47	--	F	F	B'	E	F	D	ND	E	D	E	F	B'	A	G	D	D	F	D	E	ND	F	E
P-66	RAH-46-47	D	F	F	A	D	F	D	E	E	D	F	F	A	B'	G	D	D	F	E	E	E	F	E
P-65	RAH-45-47	D	F	F	A	E	F	D	E	F	D	E	F	A	B'	G	D	D	F	E	E	E	F	E

<sup>1</sup>

B' is equivalent to B and C of Bureau of Mines analyses.



## MIDDLE FORK OF PINE CREEK, WYOMING. LOT NO. 1205.

Phosphoria formation sampled on north wall of Middle Fork of Pine Creek, sec. 35, T. 25 N., R. 118 W., Lincoln County, Wyoming, on west-dipping Tump Range monocline. Beds R-26 to U-30 sampled in trench 150 feet above creek, all other beds in trench 50-200 feet above creek. Beds R-1 to R-25 measured in natural exposures 150-400 feet above creek. Beds strike N. 10° E. and dip 26° W. Section measured by R. A. Hoppin, F. C. Armstrong, and L. E. Smith and sampled by R. S. Sears and O. A. Payne in June, July, and August 1947. Samples analyzed for  $P_2O_5$  and acid insoluble by U. S. Bureau of Mines Laboratory, Albany, Oregon, and for other constituents by Trace Elements Section Laboratory, U. S. Geological Survey, Washington, D. C.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)				Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition		
Dinwoody formation									
Td-1	Mudstone, calcareous, fos. col. nos. 47-HW-31 and 47-HW-31A <sup>1</sup>	--	1.1	--	--	--	--	1.1	--
Upper shale member of Phosphoria formation									
U-30	Phosphate rock, argillaceous, calcareous; fos. col. nos. 47-HW-30 and 47-HW-30A	RAH-43-47	2.2	18.0	--	--	--	29.1	39.60
U-29	Chert, calcareous, phosphatic	RAH-42-47	1.9	8.2	--	--	--	47.0	55.18
U-28	Chert, calcareous	RAH-41-47	1.1	1.6	--	--	--	51.3	56.94
U-27	Chert, calcareous	RAH-40-47	2.8	0.9	--	--	--	64.6	59.46
U-26	Chert, calcareous	RAH-39-47	1.0	1.1	--	--	--	62.4	60.56
U-25	Mudstone, calcareous	RAH-38-47	1.1	1.7	--	--	--	60.7	62.43
U-24	Mudstone, calcareous	RAH-37-47	1.4	4.4	--	--	--	56.1	68.59
U-23	Mudstone, phosphatic, calcareous	RAH-36-47	0.6	13.1	--	--	--	41.0	76.45
U-22	Chert, calcareous	RAH-35-47	1.6	1.7	--	--	--	60.6	79.17
U-21	Chert, calcareous	RAH-34-47	0.7	2.3	--	--	--	62.3	80.78
U-20	Chert, calcareous	RAH-33-47	0.7	2.0	--	--	--	65.2	82.18
U-19	Mudstone and limestone	RAH-32-47	1.0	1.6	--	--	--	65.2	83.78
U-18	Mudstone, calcareous	RAH-31-47	2.5	1.6	--	--	--	66.6	78.78
U-17	Mudstone, calcareous	LES-46-47	2.6	2.8	--	--	--	67.7	95.06
U-16	Mudstone, calcareous	LES-34-47	1.0	3.4	--	--	--	52.4	98.46
U-15	Mudstone, calcareous	LES-33-47	2.4	2.3	--	--	--	61.7	103.98
U-14	Mudstone, calcareous	LES-32-47	1.0	3.3	--	--	--	65.2	107.28
U-13	Mudstone, calcareous	LES-31-47	1.5	2.9	--	--	--	65.8	111.63
U-12	Phosphate rock and calcareous mudstone containing chert	LES-30-47	1.5	6.7	--	--	--	61.1	121.68
U-11	Mudstone, contains chert	LES-29-47	1.05	3.3	--	--	--	72.1	125.14
U-10	Mudstone, calcareous	LES-28-47	1.4	3.2	--	--	--	70.2	129.62
U-9	Mudstone, calcareous	LES-27-47	2.4	3.8	--	--	--	66.6	138.74
U-8	Mudstone	LES-26-47	2.5	3.4	--	--	--	73.9	147.24
U-7	Limestone, argillaceous, phosphatic	LES-25-47	0.65	8.7	--	--	--	34.7	152.90
U-6	Mudstone, calcareous	LES-24-47	3.4	5.7	--	--	--	62.6	172.28

U-5	Phosphate rock, argillaceous	LES-23-47	0.55	23.1	--	--	--	24.8	40.55	184.98
U-4	Limestone, argillaceous	LES-22-47	1.45	5.9	--	--	--	41.8	42.00	193.54
U-3	Mudstone, calcareous	LES-21-47	5.0	1.8	--	--	--	56.8	47.00	202.54
U-2	Mudstone, calcareous	LES-20-47	1.9	2.2	--	--	--	65.0	48.90	206.72
U-1	Phosphate rock, argillaceous; fos. col. no. 47-HW-29	LES-19-47	0.6	25.1	--	--	--	22.3	49.50	221.78

Rex chert member of Phosphoria formation

R-26	Limestone, phosphatic; fos. col. no. 47-HW-2B	LES-18-47	0.3	11.4	--	--	--	10.0	0.3	3.42
R-25	Limestone; fos. col. no. 47-HW-33	--	3.5	--	--	--	--	--	3.8	--
R-24	Limestone, phosphatic	--	0.3	--	--	--	--	--	4.1	--
R-23	Limestone, contains chert; fos. col. no. 47-HW-36	--	5.0	--	--	--	--	--	9.1	--
R-22	Limestone, phosphatic	--	2.3	--	--	--	--	--	11.4	--
R-21	Limestone, cherty; fos. col. no. 47-HW-37	--	5.1	--	--	--	--	--	16.5	--
R-20	Limestone and chert; fos. col. no. 47-HW-38	--	9.0	--	--	--	--	--	25.5	--
R-19	Limestone	--	2.0	--	--	--	--	--	27.5	--
R-18	Limestone and chert; fos. col. nos. 47-HW-39 and 47-HW-40	--	8.0	--	--	--	--	--	35.5	--
R-17	Limestone; fos. col. no. 47-HW-27	--	5.4	--	--	--	--	--	40.9	--
R-16	Limestone; fos. col. no. 47-HW-26	--	5.4	--	--	--	--	--	46.3	--
R-15	Limestone; fos. col. no. 47-HW-25	--	2.5	--	--	--	--	--	48.8	--
R-14	Covered interval, probably fossiliferous limestone and chert	--	23.0	--	--	--	--	--	71.8	--
R-13	Limestone; fos. col. nos. 47-HW-23 and 47-HW-24	--	11.0	--	--	--	--	--	82.8	--
R-12	Limestone and chert	--	15.0	--	--	--	--	--	97.8	--
R-11	Limestone	--	4.5	--	--	--	--	--	102.3	--
R-10	Limestone and chert	--	7.5	--	--	--	--	--	109.8	--
R-9	Limestone and chert	--	6.2	--	--	--	--	--	116.0	--
R-8	Mudstone, calcareous	--	2.5	--	--	--	--	--	118.5	--
R-7	Mudstone, calcareous	--	5.0	--	--	--	--	--	123.5	--
R-6	Mudstone, calcareous	--	5.0	--	--	--	--	--	128.5	--
R-5	Mudstone, calcareous	--	5.0	--	--	--	--	--	133.5	--
R-4	Mudstone, calcareous	--	4.0	--	--	--	--	--	137.5	--
R-3	Chert and mudstone	--	2.6	--	--	--	--	--	140.1	--
R-2	Quartzite, phosphatic	--	1.2	--	--	--	--	--	141.3	--
R-1	Mudstone, dolomitic	--	5.0	--	--	--	--	--	146.3	--

<sup>1</sup> Fossil collection made by H. Wedow, Paleontology and Stratigraphy Branch, U. S. Geological Survey.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble		
Phosphatic shale member of Phosphoria formation										
P-73	Mudstone, calcareous	LES-11-47	4.0	0.98	--	--	--	63.19	4.0	3.92
P-72	Mudstone, phosphatic, calcareous	LES-12-47	2.0	10.63	--	--	--	48.2	6.0	25.18
P-71	Mudstone, calcareous	LES-13-47	4.2	1.0	--	--	--	49.6	10.2	29.38
P-70	Phosphate rock, cherty	LES-14-47	0.7	23.8	--	--	--	26.0	10.9	46.04
P-69	Limestone, argillaceous	LES-15-47	2.8	1.8	--	--	--	42.5	13.7	51.08
P-68	Mudstone, calcareous	LES-16-47	1.7	1.2	--	--	--	73.6	15.4	53.12
P-67	Mudstone and argillaceous limestone	LES-17-47	1.5	5.3	--	--	--	29.3	16.9	61.07
P-66	Phosphate rock	LES-35-47	1.3	33.5	0.7	0.55	5.00	3.1	18.2	104.62
P-65	Phosphate rock	LES-36-47	0.7	34.9	0.8	0.65	2.98	4.1	18.9	129.05
P-64	Phosphate rock	LES-37-47	1.0	32.6	1.2	0.85	3.88	6.4	19.9	161.65
P-63	Mudstone and phosphate rock	LES-38-47	0.4	8.2	--	--	--	60.0	20.3	164.93
P-62	Limestone, argillaceous	LES-39-47	1.2	0.6	--	--	--	47.5	21.5	165.65
P-61	Phosphate rock	LES-40-47	0.9	32.0	--	--	--	6.6	22.4	194.45
P-60	Phosphate rock, argillaceous	LES-41-47	2.0	26.2	--	--	--	24.2	24.4	246.85
P-59	Phosphate rock; fos. col. no. 47-HW-22	LES-42-47	1.5	25.8	--	--	--	15.5	25.9	285.55
P-58	Mudstone, calcareous	LES-43-47	2.3	1.4	--	--	--	57.6	28.2	288.77
P-57	Phosphate rock, argillaceous	LES-44-47	0.4	25.8	--	--	--	21.7	28.6	299.09
P-56	Mudstone, calcareous	LES-45-47	2.8	0.6	--	--	--	74.9	31.4	300.77
P-55	Phosphate rock	LES-59-47	0.4	28.8	--	--	--	10.2	31.8	312.29
P-54	Limestone, argillaceous	LES-60-47	0.5	1.3	--	--	--	42.4	32.3	312.94
P-53	Phosphate rock, argillaceous	LES-61-47	0.35	22.6	--	--	--	27.6	32.65	320.85
P-52	Limestone, argillaceous	LES-62-47	1.4	0.6	--	--	--	47.1	34.05	321.69
P-51	Phosphate rock	LES-63-47	0.6	23.5	--	--	--	19.1	34.65	335.79
P-50	Phosphate rock, argillaceous	LES-64-47	0.6	16.8	--	--	--	34.6	35.25	345.87
P-49	Phosphate rock, argillaceous	LES-65-47	0.6	14.6	--	--	--	36.3	35.85	354.63
P-48	Limestone, argillaceous	LES-66-47	3.5	0.8	--	--	--	42.7	39.35	357.43
P-47	Mudstone	FCA-15-47	0.45	4.4	--	--	--	55.3	39.80	359.41
P-46	Phosphate rock, argillaceous	FCA-16-47	0.4	21.7	--	--	--	22.8	40.20	368.09
P-45	Mudstone	LES-68-47	0.45	0.2	--	--	--	61.5	40.65	368.18
P-44	Mudstone	FCA-17-47	0.5	0.1	--	--	--	66.7	41.15	368.23
P-43	Mudstone	FCA-18-47	0.65	0.4	--	--	--	73.6	41.80	368.49
P-42	Mudstone	FCA-19-47	0.5	3.2	--	--	--	67.6	42.30	370.09
P-41	Mudstone	FCA-20-47	0.35	6.4	--	--	--	55.3	42.65	372.33
P-40	Dolomite	FCA-1-47	0.8	0.5	--	--	--	7.6	43.45	372.73
P-39	Mudstone, calcareous	FCA-2-47	1.05	2.7	--	--	--	49.5	44.50	375.56
P-38	Mudstone	FCA-3-47	0.6	2.2	--	--	--	80.8	45.10	376.88
P-37	Mudstone, phosphatic	FCA-4-47	0.6	13.0	--	--	--	43.4	45.70	384.68
P-36	Limestone, argillaceous	FCA-5-47	2.3	0.4	--	--	--	42.4	48.00	385.60
P-35	Mudstone, calcareous	FCA-6-47	1.8	0.9	--	--	--	53.6	49.80	387.22
P-34	Mudstone, phosphatic	FCA-7-47	2.05	10.4	--	--	--	49.5	51.85	408.54

P-33	Limestone, argillaceous	FCA-8-47	1.3	1.6	--	--	--	33.3	53.15	410.62
P-32	Limestone, argillaceous	FCA-9-47	1.15	0.4	--	--	--	33.3	54.30	411.08
P-31	Mudstone, phosphatic	FCA-10-47	0.6	13.4	--	--	--	41.3	54.90	419.12
P-30	Limestone, argillaceous	FCA-11-47	0.9	1.3	--	--	--	22.3	55.80	420.30
P-29	Phosphate rock, argillaceous, calcareous	FCA-12-47	1.2	12.4	--	--	--	32.3	57.00	435.18
P-28	Limestone, phosphatic	FCA-13-47	0.65	9.4	--	--	--	19.2	57.65	441.28
P-27	Mudstone	FCA-14-47	0.6	7.2	--	--	--	36.3	58.25	445.60
P-26	Phosphate rock, argillaceous, calcareous, contains concretions	FCA-21-47	1.6	19.5	--	--	--	17.4	59.85	476.80
P-25	Phosphate rock, argillaceous, calcareous	FCA-22-47	0.7	14.8	--	--	--	30.4	60.55	487.16
P-24	Limestone, argillaceous	FCA-23-47	1.9	1.0	--	--	--	30.8	62.45	489.06
P-23	Limestone, argillaceous	FCA-24-47	1.1	0.6	--	--	--	24.3	63.55	489.72
P-22	Phosphate rock, argillaceous	FCA-25-47	0.9	14.1	--	--	--	31.2	64.45	502.41
P-21	Phosphate rock, argillaceous	FCA-26-47	1.1	17.5	--	--	--	29.9	65.55	521.66
P-20	Phosphate rock, argillaceous	FCA-27-47	2.7	14.2	--	--	--	32.4	68.25	560.00
P-19	Limestone	FCA-28-47	1.4	3.7	--	--	--	14.6	69.65	565.18
P-18	Limestone, argillaceous	FCA-30-47	1.0	7.6	--	--	--	21.2	70.65	572.78
P-17	Phosphate rock, calcareous, argillaceous	FCA-31-47	1.5	15.3	--	--	--	26.4	72.15	595.73
P-16	Phosphate rock, calcareous, argillaceous	FCA-32-47	1.6	17.0	--	--	--	23.7	73.75	622.94
P-15	Limestone; fos. col. no. 47-HW-14	FCA-33-47	3.6	3.4	--	--	--	11.6	77.35	635.18
P-14	Mudstone, phosphatic	FCA-34-47	0.75	9.2	--	--	--	51.8	78.10	642.08
P-13	Phosphate rock	FCA-35-47	1.35	31.1	--	--	--	5.0	79.45	684.46
P-12	Mudstone, calcareous, phosphatic	FCA-36-47	2.0	11.7	--	--	--	36.8	81.45	707.46
P-11	Mudstone, calcareous, phosphatic	FCA-37-47	0.9	10.6	--	--	--	45.3	82.35	717.00
P-10	Limestone, argillaceous	FCA-38-47	3.4	1.7	--	--	--	36.1	85.75	722.78
P-9	Limestone, argillaceous	FCA-39-47	1.3	0.3	--	--	--	35.0	87.05	723.17
P-8	Limestone, argillaceous, phosphatic	FCA-40-47	2.1	11.0	--	--	--	30.6	89.15	746.27
P-7	Mudstone, phosphatic	FCA-41-47	0.8	12.8	--	--	--	45.3	89.95	756.51
P-6	Limestone, argillaceous	FCA-42-47	0.75	1.5	--	--	--	47.2	90.70	757.64
P-5	Mudstone	FCA-43-47	1.1	4.0	--	--	--	66.6	91.80	762.04
P-4	Phosphate rock, calcareous	FCA-44-47	1.4	30.7	--	--	--	7.1	93.20	805.02
P-3	Limestone, argillaceous	FCA-45-47	2.35	0.4	--	--	--	38.4	95.55	805.96
P-2	Mudstone, phosphatic, calcareous	FCA-46-47	0.55	12.3	--	--	--	45.0	96.10	812.72
P-1	Limestone, argillaceous, phosphatic; fos. col. no. 47-HW-13	FCA-47-47	0.35	11.5	--	--	--	30.2	96.45	816.74

Wells formation

Cw-6	Limestone, cherty	FCA-48-47	0.8	0.4	--	--	--	11.0	0.8	--
Cw-5	Chert, calcareous, argillaceous	FCA-232-47	0.7	0.6	--	--	--	72.1	1.5	--
Cw-4	Chert, calcareous	FCA-231-47	1.6	0.7	--	--	--	54.4	3.1	--
Cw-3	Chert, calcareous	FCA-230-47	3.6	0.7	--	--	--	51.0	6.7	--
Cw-2	Limestone, cherty	FCA-229-47	1.5	0.8	--	--	--	43.0	8.2	--
Cw-1	Chert, calcareous	--	0.2	--	--	--	--	--	8.4	--

# SPECTROGRAPHIC ANALYSES—MIDDLE FORK OF PINE CREEK, WYOMING. LOT NO. 1205.

Semi-quantitative analyses of a few samples of the Phosphoria formation, Middle Fork of Pine Creek, Wyoming (see immediately preceding pages for location of section, thickness and description of strata, and chemical analyses of samples), made by U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch, Washington, D. C. In addition to the elements listed in the table below, Sb, As, Be, Bi, Ce, Cs, Co, Cb, Ge, In, Hg, Mo, Nd, Pt, Re, Rb, Sc, Ta, Tl, Th, and W were looked for in all samples but were not detected.

## Explanation of symbols

A = more than 10 percent  
 B' = 1-10 percent<sup>1</sup>  
 D = 0.1-1 percent  
 E = 0.01-0.1 percent

F = 0.001-0.01 percent  
 G = less than 0.001 percent  
 ND = not detected

Bed no.	Sample no.	Al	Ba	B	Cd	Ca	Cr	Cu	Fe	La	Pb	Mg	Mn	Ni	P	Si	Ag	Na	Sr	Sn	Ti	V	Y	Zn	Zr
P-66	LES-35-47	D	F	F	F	A	D	F	D	E	E	D	F	F	A	B'	G	D	D	F	E	E	E	F	E
P-65	LES-36-47	D	F	F	ND	A	D	F	D	E	E	D	F	F	A	B'	G	D	D	F	E	E	E	F	E
P-64	LES-37-47	D	F	ND	ND	A	D	F	D	E	E	D	F	F	A	B'	G	D	D	F	E	ND	E	F	E

<sup>1</sup> B' is equivalent to B and C of Bureau of Mines analyses.

LEEFE, WYOMING. LOT NO. 1213.

Part of phosphatic shale member of Phosphoria formation sampled at two places in Leefe open pit mine of San Francisco Chemical Company 4 miles west of Sage, secs. 10 and 15, T. 21 N., R. 120 W., Uinta County, Wyoming. Beds are flat lying. Section of beds P-1 to P-11 from locality A measured and sampled by R. M. Campbell in December 1947; section of beds P-1 to P-23 from locality B measured by F. W. O'Malley and R. A. Harris and sampled by Harris and R. A. Campbell in October 1948. Samples analyzed for  $P_2O_5$  and acid insoluble by U. S. Bureau of Mines Laboratory, Albany, Oregon, and for other constituents by Trace Elements Section Laboratory, U. S. Geological Survey, Washington, D. C.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble		
Locality A <sup>1</sup>										
Phosphatic shale member of Phosphoria formation—partial section										
P-11	Phosphate rock, argillaceous	RMC-145-47	2.5	17.4	2.1	1.67	9.14	31.6	2.5	43.50
P-10	Limestone, argillaceous	RMC-144-47	0.7	1.7	3.6	1.65	28.26	29.2	3.2	44.69
P-9	Phosphate rock	RMC-143-47	2.7	35.5	0.66	0.53	3.50	3.1	5.9	140.54
P-8	Phosphate rock, argillaceous	RMC-142-47	0.4	26.9	3.4	0.80	3.94	20.7	6.3	151.30
P-7	Phosphate rock	RMC-141-47	1.0	34.6	0.99	0.61	3.12	4.2	7.3	185.90
P-6	Phosphate rock	RMC-140-47	0.9	32.6	1.2	2.10	4.00	5.4	8.2	215.24
P-5	Phosphate rock, argillaceous	RMC-139-47	0.6	20.8	5.5	1.00	4.22	33.5	8.8	227.72
P-4	Phosphate rock, argillaceous	RMC-138-47	1.4	28.8	2.6	0.82	3.74	14.5	10.2	268.04
P-3	Phosphate rock, argillaceous	RMC-137-47	1.2	28.8	2.9	0.69	3.82	18.3	11.4	302.60
P-2	Phosphate rock, argillaceous	RMC-136-47	0.8	24.8	3.6	1.46	3.80	26.3	12.2	322.44
P-1	Phosphate rock, argillaceous	RMC-135-47	0.3	23.0	4.8	0.79	2.84	32.7	12.5	329.34

Locality B

Phosphatic shale member of Phosphoria formation—upper part only

P-24	Chert										
Bed P-24 may represent base of Rex member.											
P-23	Mudstone, cherty	RH-3326	2.0	3.5	--	--	--	--	--	--	7.00
P-22	Phosphate rock, argillaceous	RH-3325	0.8	23.9	--	--	--	--	--	2.0	26.12
P-21	Mudstone	RH-3324	1.3	2.9	--	--	--	--	--	2.8	29.89
P-20	Phosphate rock, argillaceous	RH-3323	0.4	28.5	--	--	--	--	--	4.1	41.29
P-19	Mudstone	WOM - 3322	1.7	3.6	--	--	--	--	--	4.5	47.41
P-18	Mudstone, phosphatic and cherty phosphate rock	WOM - 3321	1.0	18.3	--	--	--	--	--	6.2	65.71
P-17	Mudstone, phosphatic	WOM - 3320	0.4	9.5	--	--	--	--	--	7.2	69.51
P-16	Phosphate rock and mudstone	WOM - 3319	0.8	21.4	--	--	--	--	--	7.6	86.63
P-15	Phosphate rock	WOM - 3318	4.5	35.0	--	--	--	--	--	8.4	244.13
P-14	Phosphate rock, calcareous	RH-3317	1.4	26.7	--	--	--	--	--	12.9	281.51

<sup>1</sup> Beds P-1 to P-11 of locality A are probably equivalent to beds P-9 through P-18 of locality B.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble		
P-13	Phosphate rock	RH-3316	0.8	34.1	--	--	--	6.2	15.1	308.79
P-12	Phosphate rock	RH-3315	0.3	35.5	--	--	--	4.6	15.4	319.44
P-11	Phosphate rock	WOM - 3314	0.8	27.0	--	--	--	19.3	16.2	341.04
P-10	Phosphate rock	WOM - 3313	1.4	28.5	--	--	--	17.6	17.6	380.94
P-9	Phosphate rock, argillaceous	WOM - 3312	0.6	17.7	--	--	--	43.2	18.2	391.56
P-8	Mudstone	WOM - 3311	2.0	3.9	--	--	--	76.7	20.2	399.36
P-7	Phosphate rock	WOM - 3310	0.7	29.9	--	--	--	13.9	20.9	420.29
P-6	Phosphate rock	WOM - 3309	0.7	34.5	--	--	--	7.3	21.6	444.44
P-5	Phosphate rock, argillaceous	WOM - 3308	1.5	19.5	--	--	--	37.3	23.1	473.69
P-4	Phosphate rock, argillaceous	WOM - 3307	1.0	23.7	--	--	--	28.0	24.1	497.39
P-3	Phosphate rock	WOM - 3306	1.2	28.8	--	--	--	17.6	25.3	531.95
P-2	Mudstone and argillaceous phosphate rock	WOM - 3305	1.1	15.6	--	--	--	47.7	26.4	549.11
P-1	Phosphate rock, argillaceous	WOM - 3335	1.1	23.9	--	--	--	28.1	27.5	575.40

SPECTROGRAPHIC ANALYSES—LEEFE, WYOMING. LOT NO. 1213.

Locality A

Semi-quantitative analyses of samples of the Phosphoria formation, Leefe, Wyoming (see immediately preceding pages for location of section, thickness and description of strata, and chemical analyses of samples), made by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch. In addition to the elements listed in the table below, Sb, As, Be, Bi, B, Ce, Cs, Cb, Ge, Hg, Mo, Nd, Pt, Re, Rb, Sc, Ta, Tl, Th, Sn, and W, were looked for in all samples but were not detected.

Explanation of symbols

A = more than 10 percent      F = 0.001-0.01 percent  
 B' = 1-10 percent<sup>1</sup>      G = less than 0.001 percent  
 D = 0.1-1 percent      ND = not detected  
 E = 0.01-0.1 percent

Bed no.	Sample no.	Al	Ba	Cd	Ca	Cr	Co	Cu	Ga	In	Fe	La	Pb	Mg	Mn	Ni	P	Si	Ag	Na	Sr	Ti	V	Yb	Y	Zn	Zr
P-11	RMC-145-47	B'	E	ND	B'	F	ND	F	F	G	D	E	ND	E	D	E	B'	A	G	D	D	E	E	G	F	F	F
P-10	RMC-144-47	B'	E	F	A	F	ND	F	F	G	D	ND	ND	E	D	E	D	A	G	D	D	E	E	G	F	F	F
P-9	RMC-143-47	D	E	ND	A	E	ND	F	F	ND	E	E	F	E	E	E	A	B'	G	D	D	E	D	G	E	F	F
P-8	RMC-142-47	B'	E	ND	A	E	ND	F	F	G	D	E	F	E	E	E	A	B'	G	D	D	E	D	G	E	E	E
P-7	RMC-141-47	D	E	ND	A	E	ND	F	F	G	D	E	E	E	D	E	A	B'	G	D	D	E	D	G	E	E	F
P-6	RMC-140-47	D	E	F	A	E	F	F	F	G	D	E	E	E	D	E	A	B'	G	D	D	E	D	G	E	E	F
P-5	RMC-139-47	B'	E	ND	B'	E	F	F	F	G	D	F	E	E	D	E	B'	A	G	D	D	E	D	G	E	E	E
P-4	RMC-138-47	B'	E	F	A	E	F	F	F	G	D	E	E	E	D	E	A	B'	G	D	D	E	D	G	E	E	E
P-3	RMC-137-47	B'	E	F	A	E	F	F	F	G	D	E	E	E	D	E	A	B'	G	D	D	E	D	G	E	E	E
P-2	RMC-136-47	B'	E	F	A	E	F	F	F	ND	D	E	E	E	E	E	A	A	G	D	D	E	D	G	E	E	E
P-1	RMC-135-47	B'	E	ND	A	E	ND	F	F	ND	D	F	E	E	D	E	A	A	G	D	D	E	D	G	E	E	E

<sup>1</sup> B' is equivalent to B and C of Bureau of Mines analyses.